CENTER FOR TRANSPORTATION POLICY AND LOGISTICS

SCHOOL OF PUBLIC POLICY

GEORGE MASON UNIVERSITY

"Partners In Motion and Traffic Congestion in the Washington, D.C. Metropolitan Area"

Prepared for:

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EXECUTIVE SUMMARY

Partners In Motion is a program aimed at improving the quality, quantity, and availability of travel information to transportation agencies, the media, and the public in the Washington, D.C. metropolitan area. This report evaluates Partners In Motion, as it has developed over the last two years and how it may evolve over the next decade, with respect to the goal of reducing congestion. Several congestion-related objectives are considered in the evaluation.

This study uses a traffic simulation model to aid in the evaluation of Partners In Motion in terms of some of these objectives. The major facilities selected for analysis include Interstate 66 (I-66), U.S. Route 50, U.S. Route 29, and a portion of the Capital Beltway to capture spillover effects. Impacts are assessed for the A.M. peak period between the hours of 6:30 A.M. to 9:30 A.M. Several scenarios are examined: baseline (with *SmarTraveler*), baseline (without *SmarTraveler*), baseline (without *SmarTraveler* or any other Intelligent Transportation Systems (ITS)), 2010 (minimal investment in Intelligent Transportation Systems—including *SmarTraveler*), and 2010 (heavy investment in Intelligent Transportation Systems). The scenarios examined in this study evolved from discussions with Virginia Department of Transportation (VDOT) staff and other transportation experts in the region.

Several findings stem from this analysis:

- *SmarTraveler* does appear to have some impact on A.M. peak period congestion in the I-66 corridor, although the benefits are minimal and seem to apply to specific situations and travelers. For example, motorists whose trips originate north of the study area are experiencing average travel times that are less than what they would be without the service. It is important to note though that these motorists include some *SmarTraveler* users but mainly other travelers who are benefiting indirectly from the availability of the service.

- *SmarTraveler* users are not necessarily better off than other motorists in terms of making optimal departure time and route choices. In fact, the average travel time for some *SmarTraveler* users is somewhat larger than those experienced by other driver classes. This finding though is specific to motorists who use the I-66 corridor in the A.M. peak period and may not generalize to other situations. Further, in a previous study, it was found that *SmarTraveler* users believe that the service is helping them to reduce their travel times, anxiety, and traffic problems.

- The combination of Variable Message Signs, a certain degree of improved intersection signalization, traveler information services, loop detectors, and surveillance cameras and incident management have had a profound impact on reducing congestion. The average A.M. peak period travel time for tripmaking within the I-66 corridor would be 25% greater today if such systems were not in place.

- Further deployment of Intelligent Transportation Systems, including *SmarTraveler*, could enhance the effectiveness of highway and transit improvements planned for the study area. Average travel times under the heavy ITS investment are significantly lower than those associated with the scenario assuming only minimal additional deployment of ITS.

These findings provide some direction for future policies regarding ITS deployment in the Washington, D.C. metropolitan area. First, the benefits of *SmarTraveler* might be enhanced with a market share greater than the current 2%. Although there is probably some optimal penetration rate for the service that is a function of the quality, timeliness and relevance of traffic information provided by the service and the availability and use of other services. There may be diminishing returns as more and more travelers are guided to the "optimal" route. These issues could benefit from further study. Second, further development and deployment of Intelligent Transportation Systems should be encouraged. Efforts should be made to foster institutional support, interagency cooperation and coordination, the provision of privacy safeguards, and research on algorithms and models for ITS.

1. INTRODUCTION

Partners In Motion is a program aimed at improving the quality, quantity, and availability of travel information to transportation agencies, the media, and the public in the Washington, D.C. metropolitan area. This program commenced with the "Quick-Start" program on July 1, 1997 and continued with the "Full Service Dissemination" program in 1998. Partners In Motion is envisaged to continue to grow and expand as a regional traveler information system.

Several public and private agencies from the Washington, D.C. region were assembled to evaluate the Partners In Motion program. This group identified evaluation goals, which in approximate order of priority were developing intermodalism, increasing mobility, reducing congestion, guaranteeing customer satisfaction, increasing services' efficiency, increasing transit ridership, guaranteeing cost-effectiveness, improving regional attractiveness and performance, maintaining or improving the environment, and increasing institutional cooperation[1].

This report evaluates Partners In Motion, as it has developed over the last two years and how it may evolve over the next decade, with respect to the goal of reducing congestion. Some objectives related to this goal are:

- To reduce travel times during peak periods
- To guide travelers to more efficient travel paths between origins and destinations
- To guide travelers to more efficient time periods to conduct specific trips
- To improve incident response times to major accidents
- To reduce secondary accidents related to major incidents
- To divert travelers to more efficient modes of travel.

This study uses a traffic simulation model to aid in the evaluation of Partners In Motion in terms of some of these objectives. The major facilities selected for analysis include Interstate 66 (I-66), U.S. Route 50, U.S. Route 29, and a portion of the Capital Beltway to capture spillover effects (Shown on page 8). Impacts are assessed for the

[1] This report focuses only on the goal of reducing congestion, and indirectly on other goals related to improving mobility, the transportation system's efficiency, regional attractiveness and performance, and the environment. Partners In Motion has also been evaluated in terms of customer satisfaction. The results of this evaluation are reported in a separate document. The remaining goals were not evaluated as part of

A.M. peak period between the hours of 6:30 A.M. to 9:30 A.M. Several scenarios are examined: baseline (with *SmarTraveler*), baseline (without *SmarTraveler*), baseline (without *SmarTraveler* or any other Intelligent Transportation Systems (ITS)), 2010 (minimal investment in Intelligent Transportation Systems—including *SmarTraveler*), and 2010 (heavy investment in Intelligent Transportation Systems).

The scenarios examined in this study evolved from discussions with Virginia Department of Transportation (VDOT) staff and other transportation experts in the region. The heavy ITS investment scenario for year 2010 is generally consistent with VDOT's vision for future development and deployment of Intelligent Transportation Systems for system management, personal travel, and commercial vehicle operations (VDOT Smart Travel Business Plan 1997-2006). The limitations of the computer program used to conduct the simulations were also considered in the definition of scenarios.

Including the introduction, there are six sections in this report. Section 2 outlines the methodology that was employed in this study to evaluate Partners In Motion. Section 3 describes the study area as it exists today and how it might look ten years from now. Section 4 describes the scenarios that were developed for the evaluation. Section 5 addresses all of the steps that went into coding, validating, and calibrating the simulation model. The simulation results, and implications for the Partners In Motion evaluation, are summarized in Section 6. Conclusions and policy recommendations follow in Section 7.

this project due to time and resource constraints, as recognized by the evaluation team early on in the project.

2. STUDY METHODOLOGY

Traffic simulations were carried out using Version 2.10 of the computer program INTEGRATION. Aggregate transportation inputs to the corridor-level simulation model were generated from the Metropolitan Washington Council of Governments regional transportation planning model for the Washington, D.C. metropolitan area. The program MINUTP was used to extract information from the model for this purpose.

2.1. Traffic Simulation Using INTEGRATION

INTEGRATION is a mesoscopic traffic simulation model designed specifically for the analysis of integrated arterials and freeways. It is mesoscopic because it models the interactions of individual vehicles with freeways, traffic signals, and ITS, while preserving macroscopic traffic properties on each link in the network. This ability of the model to capture the dynamic interaction between multiple traffic control and management strategies is one way in which the program sets itself apart from other traffic simulation programs. Further, because the program uses dynamic queueing-based traffic assignment, driver diversion and rerouting during congested conditions can be modeled. One of the advantages of this program is that it does not require the user to collect or input data at the individual vehicle level. Instead, an algorithm internal to the program can derive microscopic measures using traffic flow characteristics and traffic demands at a more aggregate level.

The program also allows for the specification of five distinct driver types. For each class the user can identify the number of route trees (i.e., paths) available, routing strategy, the source and quality of traffic information used in making routing decisions, the frequency with which routing strategies are updated, and any special link use restrictions associated with the driver. The routing strategies available to the traveler include using any of the following: a single minimum path, multiple paths generated by the traffic assignment procedure built into the program, anticipatory routing, externally defined static routes, and externally defined dynamic routes.

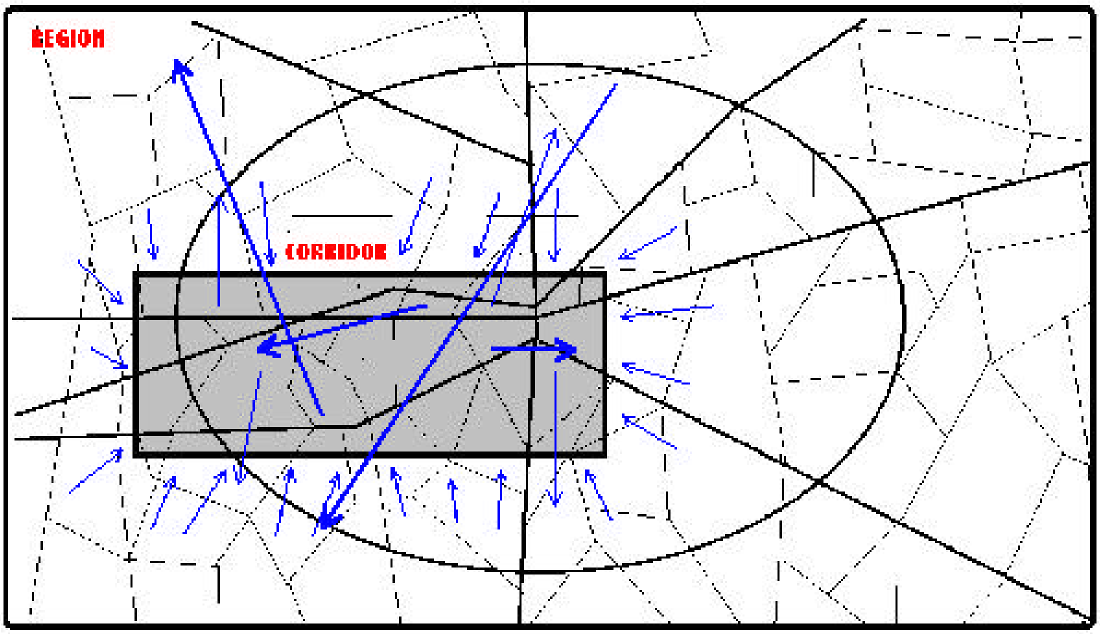
Several sources of traveler information can be specified in the program. Motorists can base their travel decisions on network travel times using one of the following: travel times generated via traffic assignment, free speed link travel times, average historical link travel times, a temporal distribution of historical link travel times, and real-time traffic data. The quality of information provided by each of these sources is modulated through a user-specified error term, which introduces an error distribution for each link's average travel time. Travelers may also receive information before leaving on a trip via the Internet for example or en-route from Variable Message Signs (VMSs), Highway Advisory Radio (HAR), or the Traffic Management Center. For each of these, the user can define the amount of time (in seconds) that the device or source affects the behavior of a particular driver class, the proportion of drivers who will actually respond to the information provided by the device, and whether or not a particular driver class responds only to Variable Message Signs and not other information devices.

INTEGRATION is ideally suited for the modeling of Advanced Transportation Management Systems. The user can specify the location and type of several real-time surveillance devices, which include link detectors, probe vehicles, and general surveillance for example. It is also possible to model sophisticated traffic signal systems like adaptive signal control. Incident management programs are not an explicit feature of INTEGRATION, although they can be modeled indirectly by controlling the total number of incidents, as well as the duration and degree of lane blockage for each incident.

2.2. Regional Transportation Modeling

One of the inputs required for the corridor-level or subarea simulation model is regional travel demand for some designated time interval (e.g., A.M. peak period). This includes an understanding of how many trips are destined for locations within the corridor, how many trips originate in the corridor, and how many trips simply pass through the corridor. The relationship between corridor-level and regional-level transportation inputs is illustrated in Figure 1.

Figure 1: Relationship Between Regional Traffic Flows and Corridor-Level Network



This study uses the Metropolitan Washington Council of Government's regional transportation planning model to generate existing and 2010 estimates of aggregate travel demand in the Washington, D.C. metropolitan area. This model is based on the traditional four-step modeling process, which captures each of the following:

trip generation or number of trips produced in and attracted to each zone in the transportation study area,

trip distribution or number of trips going between each origin and destination, or each pair of zones in the study area,

mode choice or travelers choice of mode (e.g., drive alone, car pool, transit), and

traffic assignment or travelers choice of routes between each origin and destination.

The transportation planning model used in this study encompasses the entire Washington, D.C. metropolitan area, including the counties of Fairfax, Montgomery, Prince William, Prince Georges, part of Loudoun; the independent cities of Arlington, Alexandria, Fairfax City, Manassas Park, and Manassas, and the District of Columbia. There are 1478 transportation analysis zones (TAZs), 193 Transportation Analysis

Districts (TADs), or aggregations of TAZs. The highway network includes all interstates, highways, and major arterials in the metropolitan area.

There are six different trip types or purposes in the model: work, shopping, other home-based trips, non-home-based trips, light and medium trucks, and heavy trucks. Each trip type has a different trip generation rate. Trip distribution generates an origin-destination matrix where for each pair of zones, demand is a function of the travel impedance between zones, and the push and pull effects of each zone.

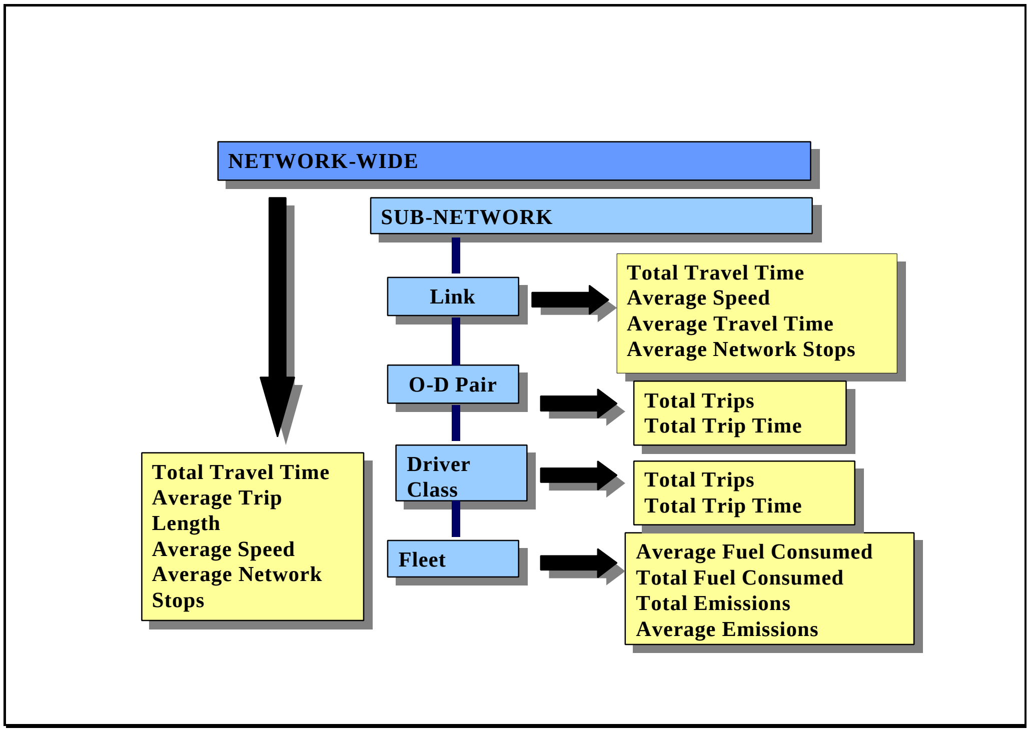
Trips are assigned to the highway network using a "three-iteration, capacity restrained assignment" method. In the first iteration, the computer selects the shortest (in terms of travel time) route or path between each pair of zones, and based on these selections, loads one-fourth of all vehicles onto the network. Based on this assignment, travel speeds and times are updated, and used by the computer in the next iteration to select the shortest routes between each pair of zones. Subsequently, an additional one-fourth of all vehicles are loaded onto the network. This process is repeated for a third time, assigning the remaining vehicles to the network.

The output generated by the assignment phase was used as input to the corridor-level model. The following trips were extracted from the regional trip file: those entering or exiting from the corridor, those traveling through the corridor and those traveling within the corridor. Total daily trips were converted to A.M. peak hour levels using k-factors and some other knowledge of what the directional distribution of traffic looks like during this time of day.

2.3. Evaluation of Partners In Motion

The modeling framework introduced in this section generates a variety of outputs that are appropriate evaluation metrics for this study. Using these measures, which are illustrated in Figure 2, Partners In Motion will be evaluated in terms of the following objectives: guidance of travelers to more efficient travel paths between origins and destinations, and reductions in travel times during peak periods. The last objective will be examined from three perspectives: system-wide, driver-class specific, and facility-specific. Additionally, two objectives not on the list related to environmental impacts will be examined. The INTEGRATION program produces a set of fleet-related outcomes which will allow for the evaluation of Partners In Motion in terms of it's impact on reducing vehicular emissions and fuel consumption during peak periods. The INTEGRATION program is not well-suited for the analysis of incident management systems, shifts in mode share, or the use of telecommuting by commuters. Therefore, Partners In Motion will not be evaluated in terms of the last four objectives outlined in Section 1.

Figure 2: Summary of INTEGRATION Output Measures



The evaluation summarized in this report is the product of several stages of work. They included:

- ✓ Defining the scenarios to be examined (i.e., base case versus future), including the forecast horizon.
- ✓ Defining and coding the network for use in INTEGRATION.
- ✓ Estimating origin-destination flow demands to be applied to the corridor-level model.

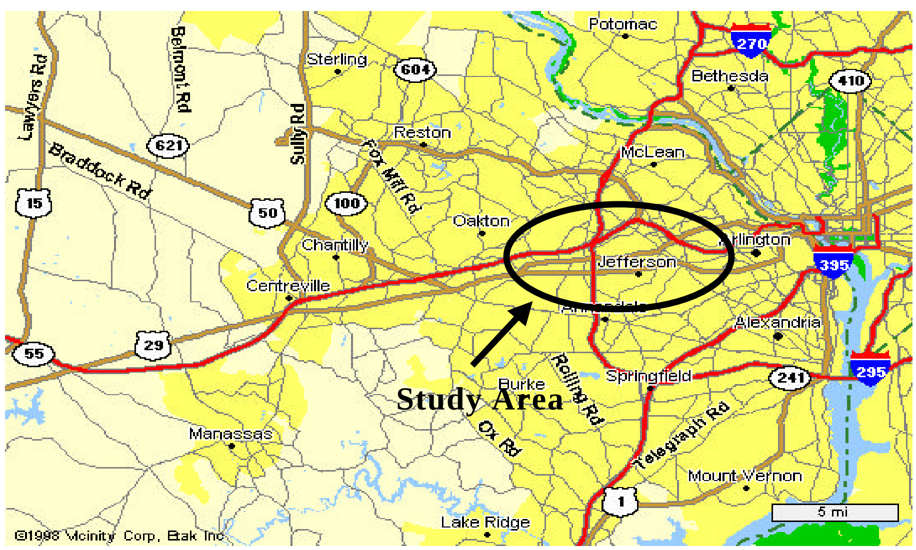
- ✓ Calibrating the link speed-flow relationships and capacities.
- ✓ Validating the model.
- ✓ Simulating and processing the results.

Each of these steps had to be completed for both the base year (1999) and forecast year (2010). This process is described in more detail in the sections that follow.

3. DESCRIPTION OF STUDY AREA

The area selected for study includes a portion of the I-66 corridor located in the western suburbs of the Washington, D.C. metropolitan area (See encircled area in Figure 3). The specific section extends from the Seven Corners area west of Baileys Crossroads and Roosevelt Blvd. to Fairfax Circle west of Vienna/GMU Fairfax Metro. The entire stretch of I-66 runs from I-81 just east of the Shenandoah mountains to the Potomac River in Washington, D.C. I-66 is a critical link in the Washington, D.C. highway network, connecting with other major facilities such as the Capital Beltway and I-81. The decision to use I-66 as a case study is based on a couple of factors. First, *SmarTraveler* covers I-66, as well as U.S. Route 50 and the Capital Beltway, which are two other major highway segments in the corridor. Second, there is strong potential for further ITS deployment in the corridor and for significant benefits to be derived as a result of this action.

Figure 3: Map of Study Area



3.1. Transportation Alternatives in the Corridor

There are numerous transportation alternatives in the I-66 corridor. Motorists traveling east-bound or west-bound have three major routes to select from: I-66, U.S. 29 and U.S. 50. There are also opportunities for mode choice. On I-66, there is one High Occupancy Vehicle (HOV) lane going inbound from 234 to the Capital Beltway and two onward from this point to the Roosevelt Bridge during the A.M. peak period (6:00 to 9:00 A.M.). During the P.M. peak period (4:00 to 7:00 P.M.), the reverse exists going west-bound.

According to the 1990 Census, more than 15% of commuters in the Washington, D.C. region participated in some type of ridesharing arrangement, the fifth highest rate in the nation. Car occupancy rates for commuting trips averaged 1.16 person trips per car in 1990. These rates vary by market, with higher occupancy rates occurring for trips from the suburbs to downtown core—e.g., I-66 inbound[2].

Public transit is also an option for travelers in the I-66 corridor. There is a METRO rail line that runs in the median of I-66, between Nutley Street and points closer into the District of Columbia. Additionally, METRO, and other local bus services such as the Fairfax County Connector, have bus routes that service the study area.

3.2. Congestion and Delay

Traffic congestion is a major problem for the Washington, D.C. area. Travel estimates for 1990 indicate that the volume of traffic on the area's roadways was greater than the available highway capacity. The region suffers from the second highest per capita delays in the nation. In addition, the region's annual cost per vehicle, accounting for both fuel and lost time, is the worst in the nation. Some locations of severe congestion for the peak periods of morning and evening weekdays are eastbound and westbound segments of I-66.

[2] See the *1997 Update to the Financially Constrained Long-Range Transportation Plan for the National Capital Region*, National Capital Region Transportation Planning Board, July 15, 1998.

I-66 is typical of other major metropolitan highway facilities having two distinct peak periods of traffic, once in the A.M. and again in the P.M (see Figures 4 and 5[3]). During the A.M. peak period, the average travel time inbound is as high as 42 minutes[4]. US Route 50 also has a similar pattern of usage although the peaks are much less severe than those that exist on I-66. It is important to note though that US Route 50 has considerably more travel time variability than I-66, particularly during the A.M. peak period[5]. This condition might mean that travelers have greater uncertainty about traffic conditions on US Route 50, which could affect the attractiveness of this route in relation to I-66.

The I-66 corridor is the location of several traffic bottlenecks. A bottleneck location is defined here as an area that has a Level of Service of F (40 or more vehicles per lane per mile) for a period of one hour or more over several days. During the A.M. peak period, one bottleneck extends from VA 243 (Nutley St.) to the Capital Beltway on I-66. Some of this delay likely occurs as single-occupant vehicles are diverted from I-66 to the Capital Beltway between 7:00 and 9:00 A.M., when the inbound HOV restrictions are in effect on I-66 inside the beltway. Table 1 provides some evidence of this diversion. Traffic on I-66 just inside the beltway drops significantly during this time period, while for alternative routes such as U.S. 50 and U.S. 29 traffic levels increase. There is a similar pattern for traffic traveling outbound in the P.M. peak period, as shown in Table 2.

[3] Mitretek collected travel times from the *SmarTraveler* Internet site and the use of probe vehicles from Centreville to the Roosevelt Bridge on I-66 and from the Fairfax County Parkway to the Roosevelt Bridge on U.S Route 50. The *SmarTraveler* Internet site is accessed every five minutes from 5:30 A.M. to 10:00 P.M. daily and travel times downloaded into a file. Data was not collected on weekends. Over 10,000 records were collected during the months of September in 2000. The use of probe vehicle involves the use of a laptop computer and a Global Positioning Satellite (GPS) uplink.

[4] This is between Centreville and the Roosevelt Bridge.

[5] Standard deviations of the collected travel times for the A.M. peak period on Rt. 50 are higher than those for I-66.

Figure 4: Westbound Travel Time Variability on I-66[6]

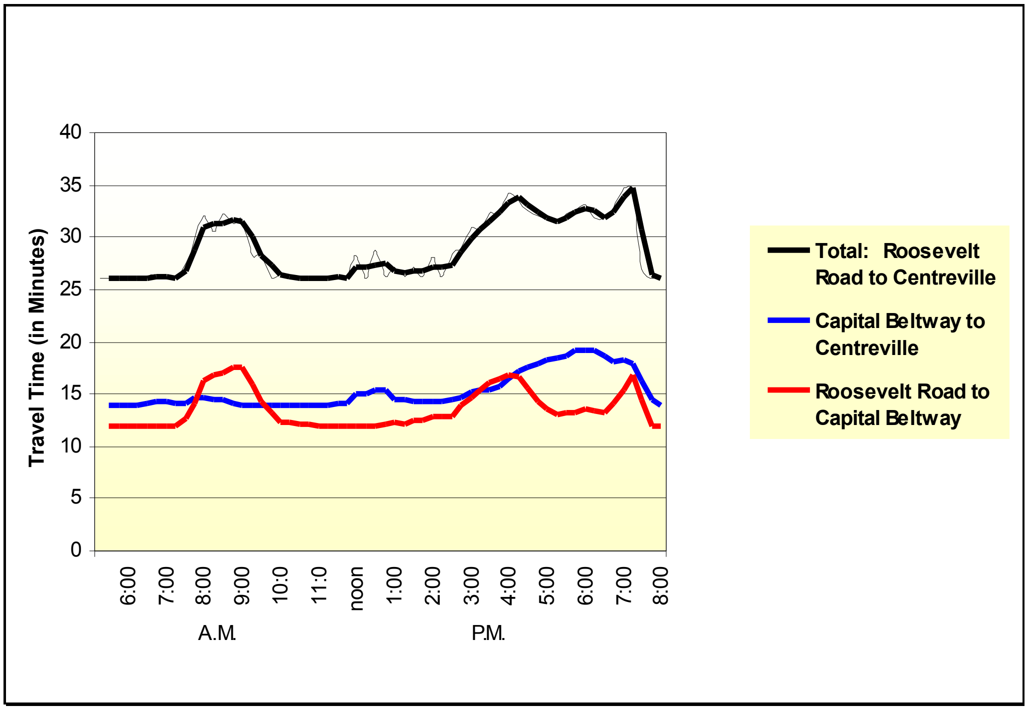
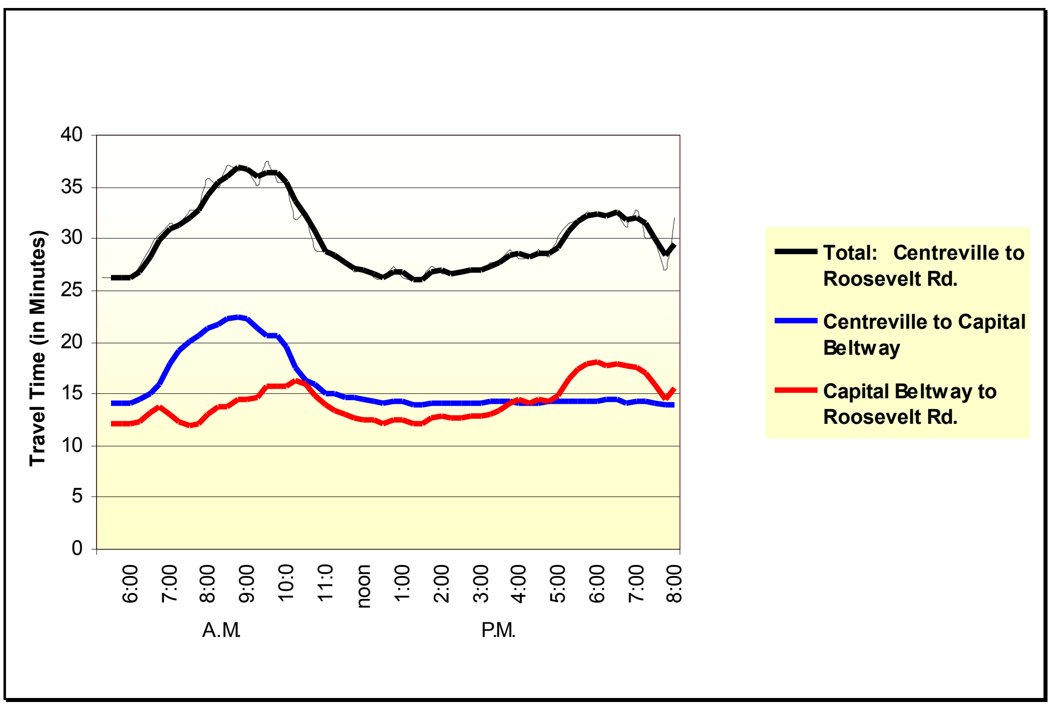


Figure 5: Eastbound Travel Time Variability on I-66



[6] Congestion in these figures is measured in terms of the average time it takes a motorist to drive between Centreville and the Roosevelt Bridge.

Table 1: Inbound A.M. Peak Period Beltway Cordon Traffic Counts

Time	I-66	Leesburg Pike	Dulles Access Road	Route 29	US 50 (Arlington Blvd.)	Gallows Road
6:30	1556	463	962	199	847	99
7:00	695	752	1124	513	1298	181
7:30	854	1125	1241	786	1640	317
8:00	855	882	1289	766	1593	314
8:30	745	846	1078	694	1473	318
9:00	728	983	834	609	1448	266
9:30	1263	837	1168	510	1116	289
Total	5140	5631	6896	3878	8568	1685

Source: *1998 Beltway Cordon Count*, National Capital Region Transportation Planning Board

Table 2: Outbound P.M. Peak Period Beltway Cordon Traffic

Time	I-66	Leesburg Pike	Dulles Access Road	Route 29	US 50 (Arlington Blvd.)	Gallows Road
3:30	1351	407	579	539	847	420
4:00	1483	908	1292	562	1327	398
4:30	1002	915	1400	607	1427	424
5:00	902	1073	1329	642	1408	482
5:30	1091	1165	1239	626	1235	464
6:00	1129	984	1167	633	1444	527
6:30	1033	1032	1513	648	1203	477
Total	2485	6077	7940	3718	8044	2772

Source: *1998 Beltway Cordon Count*, National Capital Region Transportation Planning Board

The I-66 corridor is a major focus for transportation improvement projects. The I-66 Corridor Major Investment Study (MIS), co-sponsored by the Virginia Department of Rail and Public Transportation (DRPT) and the Virginia Department of Transportation (VDOT), examines the highway from its interchange with the Capital Beltway west to U.S. Route 15 in Prince William and Loudoun Counties. The primary reason the study recommends expansion of the I-66 Corridor's transportation capacity is the expected growth in population and employment in the area over the next 20-25 years. The Metropolitan Washington Council of Government's most recent demographic and economic forecasts show an increase in population of 15% between now and 2010, and a 19% for employment over this same time period (See Tables 3 and 4). Within Fairfax County, where the study area is located, roughly the same growth rates in population and employment are anticipated.

The net effect of this growth is an expected increase of 79% in work-related trips along the I-66 Corridor. This increase in transportation needs will exacerbate problems on facilities that are already heavily utilized. The MIS reports that traffic volumes in the study area increased by between 56 and 121% between 1985 and 1996 to approximately 196,000 vehicles per day just west of the I-495 interchange. Traffic volumes have increased even more dramatically on north-south routes in the study area: U.S. Route 15 and State Routes 234 and 28 have increased between 76 and 306% over the last decade. In addition, the 5,000 parking spaces provided at both the Vienna and Dunn Loring stations are generally filled to capacity by 7:30 A.M.

The MIS recommends several projects to be implemented over the next decade that are relevant to the study here:

- Upgrading the High Occupancy Vehicle lanes on I-66 to HOV3; and,
- Adding one lane of HOV to the Capital Beltway.

Additionally, the currently adopted Constrained Long Range Plan includes the following projects:

- Widening of U.S. Route 29 from 4 to 6 lanes through the City of Fairfax and from the City of Fairfax to the Capital Beltway.
- Upgrading VA 123 to six lanes between US 50 and I-66.
- Expanding Leesburg Pike to five lanes.

Table 3: Employment Trends in the Washington, D.C. Metropolitan Area
(Employment in 1000's)

JURISDICTION	1990	2000	2010	2020	2000-2010	2000-2020
District of Columbia	747.3	678	752	807.1	11%	19%
Arlington County	183.1	201.2	236.9	275.4	18%	37%
City of Alexandria	93.20	98.6	110.40	115.90	12%	18%
Central Jurisdictions	1,023.60	977.8	1,099.30	1,198.40	12%	23%
Montgomery County (1)	466	536	626	660	17%	23%
Rockville (2)	56.9	73	83	86.6	14%	19%
Prince George's County	310.4	325.3	385.2	449.1	18%	38%
Fairfax County	403.7	526.4	644.4	701.3	22%	33%
City of Fairfax (3)	26.9	30.8	32.6	32.7	6%	6%
City of Falls Church	9.20	9.40	9.60	9.70	2%	3%
Inner Suburbs	1,216.10	1,428.00	1,697.70	1,852.80	19%	30%
Loudoun County	39.3	85.3	145.5	202.7	71%	138%
Prince William County	68.8	90.6	118.5	141.2	31%	56%
Manassas & Manassas Park	18.7	21.6	24.7	25.4	14%	18%
Other (4)-(6)	121.8	193.3	232.6	272.2	20%	41%
Outer Suburbs (6)	248.6	390.8	521.3	641.5	33%	64%
Northern Virginia	853.8	1,082.20	1,348.00	1,536.80	25%	42%
Suburban Maryland (6)	887.1	1,036.40	1,218.40	1,348.70	18%	30%
REGIONAL TOTAL (6)	2,488.30	2,796.60	3,318.30	3,692.60	19%	32%

Source: www.mwcog.org

Notes:
(1) Forecasts for years 2000 to 2025 include all of Takoma Park.(2) Included in Montgomery County total.(3) Totals for all years include Fairfax County Government employees working in the Massey Complex, located within the boundaries of the City of Fairfax.(4) Tri-County Council for Southern Maryland develops ten-year incremental population, housing unit and employment forecasts for Calvert County, Charles County and St. Mary's County.(5) Source: Rappahanock Area Development Commission, November 1997.(6) Forecasts for Anne Arundel and Howard counties are shown for reference purposes only and are not included in any other totals. Anne Arundel and Howard counties participate in the Cooperative Forecasting programs of the Baltimore Metropolitan Council and the Metropolitan Washington Council of Governments.

Table 4: Population Trends in the Washington, D.C. Metropolitan Area
(Population in 1000's)

JURISDICTION	1990	2000	2010	2020	2000-2010	2000-2020
District of Columbia	606.9	518.1	554.7	618.6	7%	19%
Arlington County	170.9	192	201.4	212.9	5%	11%
City of Alexandria	111.20	127.1	135.30	140.90	6%	11%
Central Jurisdictions	889.00	837.2	891.40	972.40	6%	16%
Montgomery County (1)	757	855	945	1000	11%	17%
Rockville (2)	44.8	51.8	59.1	60	14%	16%
Prince George's County	729.3	784.6	852.4	940.9	9%	20%
Fairfax County	818.6	968.2	1112.9	1203.7	15%	24%
City of Fairfax (3)	19.6	21.7	22.7	22.8	5%	5%
City of Falls Church	9.60	10.40	10.70	10.90	3%	5%
Inner Suburbs	2,378.90	2,691.70	3,002.80	3,238.30	12%	20%
Loudoun County	86.1	172.2	304.2	439	77%	155%
Prince William County	215.7	286.1	350.5	387.1	23%	35%
Manassas & Manassas Park	34.7	43.2	45.4	46	5%	6%
Other (4)-(6)	364	471.6	571.4	673.9	21%	43%
Outer Suburbs (6)	700.5	973.1	1271.5	1546	31%	59%
Northern Virginia	1527.6	1,899.50	2,279.10	2,557.00	20%	35%
Suburban Maryland (6)	1789	2,032.70	2,272.80	2,477.20	12%	22%
REGIONAL TOTAL (6)	3,923.60	4,450.30	5,106.60	5,392.00	15%	21%

Source: www.mwcog.org

Notes:

(1) Forecasts for years 2000 to 2025 include all of Takoma Park.(2) Included in Montgomery County total.(3) Totals for all years include Fairfax County Government employees working in the Massey Complex, located within the boundaries of the City of Fairfax.(4) Tri-County Council for Southern Maryland develops ten-year incremental population, housing unit and employment forecasts for Calvert County, Charles County and St. Mary's County.(5) Source: Rappahanock Area Development Commission, November 1997.(6) Forecasts for Anne Arundel and Howard counties are shown for reference purposes only and are not included in any other totals. Anne Arundel and Howard counties participate in the Cooperative Forecasting programs of the Baltimore Metropolitan Council and the Metropolitan Washington Council of Governments.

3.3. Intelligent Transportation Systems

3.3.1. Traveler Information Services

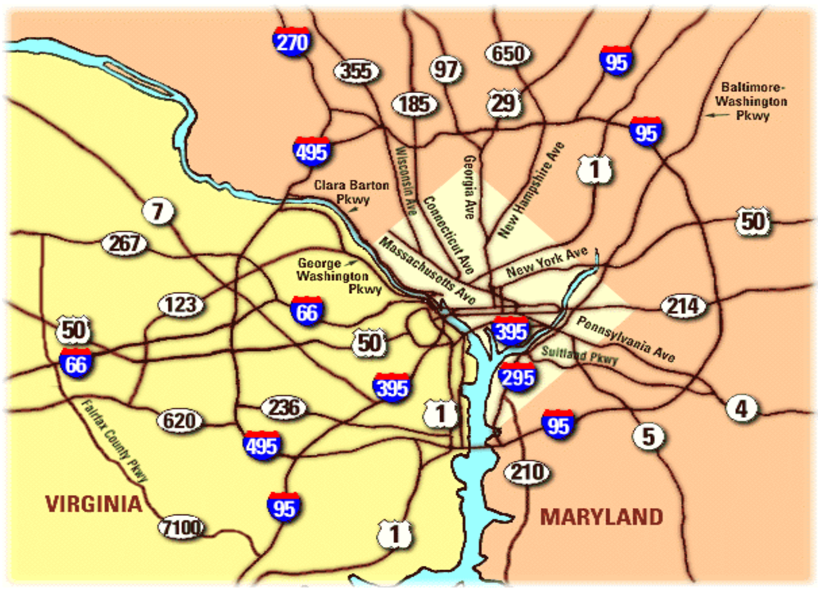
Travelers in the Washington, D.C. area currently have access to travel information through a variety of sources, including *SmarTraveler*, the radio, television, Internet, and Variable Message Signs. These sources differ in the quality of information provided, the frequency with which the information is updated, geographical coverage of the information, the format in which the information is presented, the dissemination medium, and the degree of customer interaction with the service (i.e., one-way or two-way).

The Partners In Motion program was introduced in 1997 to promote the development of a suite of information services that would be of higher quality than traditional sources of information, such as those provided on the radio and television. The *SmarTraveler* phone service and *SmarTraveler* web page for the Washington, D.C. metropolitan were instituted in the summer of 1997. Both are still operating. The phone service allows travelers to access, using a land line or cell phone, estimated travel times for major highway segments and METRO rail information. Customers punch their way through a menu to retrieve information pertinent to their trip.

The *SmarTraveler* web page offers similar information, although in a different format. After accessing the web site, users are presented with a map, where they click on to that part of the highway network for which they would like information (See Figure 6). Estimated travel times are updated every five minutes on both the web site and telephone service. In 1998, *SmarTraveler* T.V., a cable channel devoted exclusively to traffic and weather in this area, was introduced. The program airs from 5:30 to 9:30 and is only available to residents of selected jurisdictions in the Washington, D.C. metropolitan area[7]. Due to a lack of revenue, this service was discontinued in January 2001. Other dissemination devices, such as hand-held computers, are currently being explored as part of the Partners In Motion program.

[7] Alexandria, Prince George County, northern Anne Arundal County, Prince William County, portions of Fairfax County including Reston.

Figure 6: *SmarTraveler* Web Page Interface



Many local radio stations also provide periodic traffic updates for major highways in the Washington, D.C. metropolitan area. Highway Advisory Radio (HAR), broadcasted on A.M. radio, alerts travelers to traffic delay resulting from workzone activities and incidents and suggests alternative routes of travel. Variable Message Signs (VMSs) refer travelers to Highway Advisory Radio and also provide information on congestion ahead. Local morning and early evening news programs offer periodic updates on traffic using live CCTV camera images and maps highlighting trouble spots. Coverage is limited to major highways and locations where CCTV cameras exist.

3.3.2. Use of Traveler Information Services

SmarTraveler is a relatively new service in this area. Therefore, it is not surprising that the market penetration for this service is still low in comparison to other traveler information services[8]. In 1999, the *SmarTraveler* phone service, web page, and

[8] The numbers presented in this section are based on several surveys conducted by the School of Public Policy. These surveys included a phone survey of *SmarTraveler* phone service customers,

Cable channel captured 1.4%, 3.7%, and 2% of the driving age population[9]. In comparison, 45% of the population accessed traffic information by watching local television programs, 63% by listening to the radio, and 4% by looking on the Internet[10] (See Table 5). The Internet category includes all traffic information web pages including *SmarTraveler*, which means that *SmarTraveler* has captured 93% of the web marked for traveler information in the area.

Table 5: Market Penetration of Traveler Information Services in the Washington, D.C. Metropolitan Area (1999)

Services	Total	Work Pre-trip	Work En-route	Non-work Pre-trip	Non-work En-route
TV	45%	73%	N/A	64%	N/A
Radio	63%	54%	76%	60%	79%
Internet	4%	N/A	N/A	N/A	N/A
SmarTraveler Web	3.7%	N/A	N/A	N/A	N/A
Phone	1.4%	1.0%	0.8%	0.6%	0.5%
Cable	2.0%	N/A	N/A	N/A	N/A

Source: Partners In Motion and Customer Satisfaction in the Washington, D.C. Metropolitan Area, prepared for the Federal Highway Administration, Virginia Department of Transportation, and Partners In Motion Evaluation Subcommittee, 2000.

The *SmarTraveler* phone service tends to be used mainly by commuters rather than those travelling for non-work-related purposes. Over half of those who use the service do so regularly before leaving for work and/or while commuting[11]. Nevertheless, most travelers still rely on the radio or television to get traffic information, regardless of trip purpose[12].

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an Internet-based survey of *SmarTraveler* users, and a phone survey of driving-aged residents of the metropolitan region. The first two surveys were conducted in 1998 and 1999, while the last was executed in 1997 as well.

[9] These shares are not mutually exclusive and include customers of multiple services.

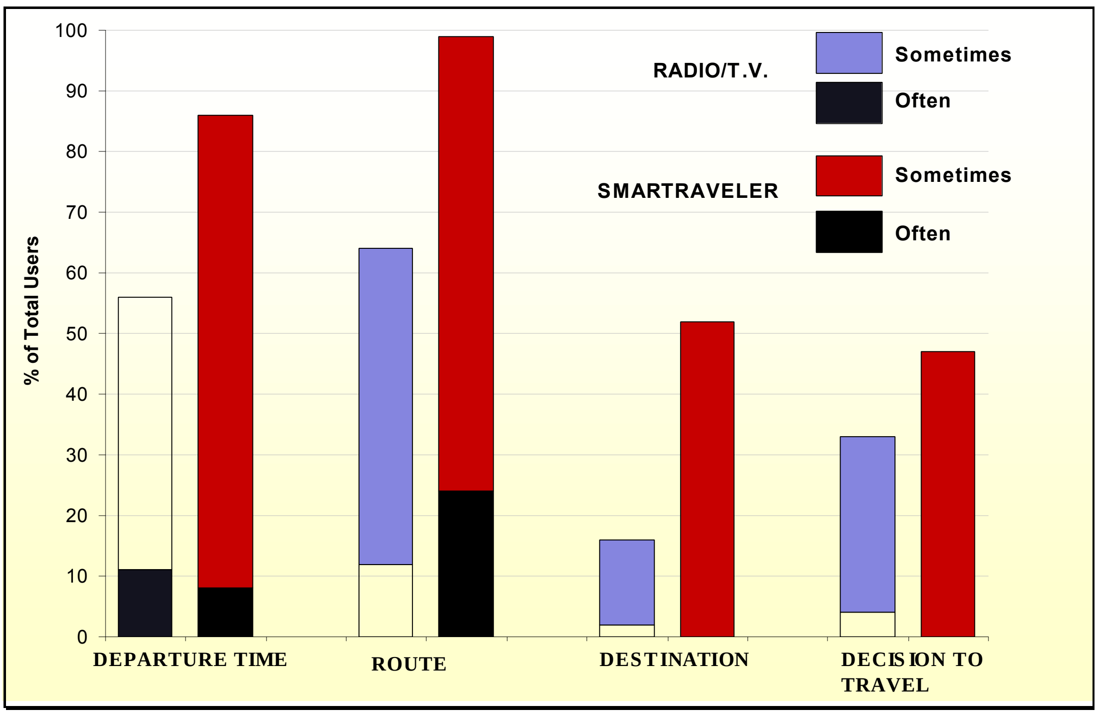
[10] The Internet web sites here do not include the *SmarTraveler* page.

[11] Source: Partners In Motion and Customer Satisfaction in the Washington, D.C. Metropolitan Area, prepared for the Federal Highway Administration, Virginia Department of Transportation, and Partners In Motion Evaluation Subcommittee, 2000.

[12] The television category in Table 2 does include *SmarTravel* T.V., a cable channel that airs travel information exclusively. Although use of this service in relation to other channels that provide traffic reports is believed to be inconsequential.

Traveler information services in the Washington, D.C. metropolitan area appear to be having some influence on travel behavior in this region[13] (see Figure 7). *SmarTraveler* phone service users appear to have a higher propensity to change their travel behavior than those who get traffic reports from the television or radio. This service seems to be having the strongest impact on departure time and route choices. In fact, nearly all of those who use the phone service change their route at least sometimes after receiving information from the system.

Figure 7: Traffic Information and Perceived Changes in Travel Behavior



Traveler information services appear to be having less of an impact on travelers' destination choices and decisions to travel. This is not surprising however given that most individuals who use traveler information services are commuters, whose work destinations are fixed. This could change though as workplaces continue to implement programs to encourage teleworking, telecommuting, and other flexible work arrangements.

[13] It should be noted that the responses reported in this section are "stated" responses rather than actual measurements. In other words, the responses represent the group's perception of impacts.

3.3.3. Traffic Management and Control

The 24-hour Northern Virginia Smart Traffic Center manages and controls traffic in a large part of the I-66 corridor. This area includes the ten mile stretch of I-66 between the Capital Beltway and Roosevelt Bridge and the HOV facilities on I-66. The City of Fairfax manages traffic within it's own municipal boundaries.

The Northern Virginia Smart Traffic Center uses 550 loop detectors, 48 closed circuit television cameras and aerial surveillance to monitor 31.5 miles of highway. Loop detectors, which are spaced every ½ mile along I-66 and I-395, observe traffic volumes, vehicular speeds, and spacing between vehicles. Monitored highways in the study area include 10 miles of I-66 inside the beltway, 11.5 miles of I-395 inside the beltway and 10 miles of the beltway between the Woodrow Wilson Bridge and Springfield. In addition, 26 of 100 highway ramps are under meter control on I-66 and I-395. On-call incident management services patrol 81 miles of highway using public operated patrol vehicles, during peak travel periods. The police cover 110 miles of highway and 1,000 miles of arterial roads for incident management. Extending the TMS area of coverage to include 20 miles on I-66 and 20 miles on I-95 is under consideration. On these 40 miles, an additional 50 closed-circuit TVs, 1500 loop detectors, and 100 variable message signs are planned to be added to the system.

SmarTraveler uses probe vehicles to estimate travel times for selected highways in the study area, which include I-66, U.S. Route 50, and the Capital Beltway. The actual number of probe vehicles on the roads however is still relatively low. Traffic conditions are also monitored via video feeds. *SmarTraveler* reports the information it collects through these means to travelers via its phone service and web page.

Ramp meters are used to regulate traffic flow entering onto I-66 during peak periods. There are currently ramp meters located inside the Beltway although not within the area selected for study in this evaluation. The Virginia Department of Transportation's Smart Traffic Signal System allows for signal adjustments in response to changing traffic conditions and for central control of signal timing. MIST provides real-time graphics display of operations at intersections, which can help in optimizing signals. Fairfax City has it's own signal system.

4. DEFINITION OF SCENARIOS

Several scenarios were defined for the purpose of evaluating Partners In Motion. These scenarios evolved from discussions with Virginia Department of Transportation (VDOT) staff and other transportation experts in the region and from an understanding of the capabilities and limitations of INTEGRATION. Each of the scenarios developed for the evaluation are summarized in Table 6 below. See attached Tables 7, 8, 9 for a more thorough description of the scenarios.

Table 6: Overview of Scenarios

BASE (1999)	Scenario 1	No ITS
	Scenario 2	ITS, no *SmarTraveler*
	Scenario 3	ITS, with *SmarTraveler*
FUTURE (2020)	Scenario 4	Minimal ITS investment
	Scenario 5	Heavy ITS investment

4.1. Base Cases

Scenario 3 describes the study area as it exists today, as discussed in Section 3.3. This scenario assumes that 2% of all travelers in the Washington, D.C. metropolitan area regularly or sometimes access traffic information from at least one of the *SmarTraveler* services: Web page, phone, or television while half of all travelers listen to traffic reports on the radio and/or television. The remaining travelers base their travel decisions on historical experience and have limited knowledge about travel times and conditions on routes they do not normally utilize, or they rely on the radio or television for traffic information. During the A.M. peak period, the proportion of travelers falling into the first category is 23%, while for the second type there are 75%. Variable message signs provide information to all motorists who pass areas where they are positioned on I-66 and the Capital Beltway. The information provided by *SmarTraveler* is assumed to be somewhat more comprehensive than that disseminated through the more traditional channels (i.e., radio and television) and Variable Message Signs.

This scenario also assumes some degree of traffic surveillance. Loop detectors, helicopter, video cameras monitor traffic conditions on select portions of I-66, U.S. Route 50, U.S. Route 29, and the Capital Beltway. The number of probe vehicles on the road during the A.M. peak period is extremely low, and therefore are excluded from

Scenario 3. While many intersections in the study area are signalized, only those with major traffic are captured in the base case simulations. See Tables 7 through 9 for a more detailed description of Scenario 1.

Scenario 2 is similar to Scenario 3 although it assumes the absence of *SmarTraveler*. Scenario 3 assumes the absence of *SmarTraveler* and all Intelligent Transportation Systems.

4.2. Future Scenarios

Two additional scenarios were defined for the purpose of evaluating how further expansion of *SmarTraveler*, and the deployment of other Intelligent Transportation Systems, could impact congestion and delay in the Washington, D.C. metropolitan area. Both 2010 and 2020 were considered as forecast horizons for the study. The regional transportation data needed for input to the simulation model is available for both years. This data includes TAZ-level estimates of population and employment, origin and destination demand flows, and planned highway improvements for the metropolitan area. The year 2010 was ultimately selected because it is a much more reasonable time frame within which to forecast the evolution and adoption of technology.

Scenario 4 assumes the Scenario 1's level of ITS deployment, but with 2010 highway improvements, as well as population and employment levels for that year. Scenario 5 assumes heavy investment in ITS. There will be a greater level of surveillance, expanding to more highways and arterials in the study area. More CCTV cameras will be put in place and approximately one-third of all vehicles will be equipped with transponders allowing for travel times to be collected. The information collected will go to a central traffic management center, or integrated centers. There will be vast improvements in information collection and dissemination resulting from heavy investment in ITS for surveillance, incident detection, communications, data processing, and other functions. Almost one-half of all motorists will access information on traffic conditions and travel times for all arterials and highways in the study area via *SmarTraveler* or some other information service (e.g., 511). The integration of cable television and Internet will allow motorists to access relatively good information on many highways and arterials in the study area. Approximately one-third of all motorists will subscribe to an advanced traveler information service, which provides real-time route-guidance.

Scenario 5 is based on a number of assumptions. First, there will be institutional support for the development and deployment of Intelligent Transportation Systems. This is a reasonable assumption. One organization that strongly supports ITS is the Virginia Department of Transportation. The VDOT Smart Travel Business Plan (1997-2006) encourages the development and implementation of ITS in Virginia, including the Northern Virginia area where the I-66 corridor is located.

In the near term (3-5 years), VDOT anticipates beginning widespread deployment of near real-time traffic control, continue to expand ATMS coverage, and implement Integrated VDOT Data Sharing. Some technological developments over this period will be the use of vehicles as probes, the implementation of adaptive signal control systems and the development of data user service. During this time period, VDOT also anticipates the diffusion of in-vehicle systems that communicate real-time route and guidance information to travelers. Over the long term (6-9 years), VDOT will begin deployment of "traffic responsive ATMS systems", expand the coverage of these systems, and implement "integrated multi-agency data sharing." VDOT also anticipates expanding ATIS services as ATMS expands. Support for ITS stems from other agencies as well. The Metropolitan Washington Council of Governments, in combination with other organizations, is working to incorporate ITS into the planning process.

Second, there will be greater coordination between public sector entities in the management and control of traffic. Most barriers to communications between jurisdictions with authority in the study area will be removed. Considerable progress will be made in the resolution of institutional barriers to inter-jurisdictional cooperation in traffic management. This is consistent with the Virginia Department of Transportation's vision for system management and personal travel. VDOT sees the deployment of sophisticated, integrated transportation management systems in the urban areas of Northern Virginia:

> *"The centers will serve as transportation system management "nerve centers" receiving information from CCTV and vehicle detectors…Within operations centers, VDOT, local agencies, transit, and police personnel will work together using sophisticated decision support systems to immediately enact control*

> *strategies based on near real-time conditions." Further, VDOT envisages greater data sharing between agencies. ... "ITS data will be shared with the private sector for the provision of personal travel services on a statewide basis."* (VDOT Smart Travel Business Plan)

Third, there will be greater cooperation with the private sector to develop and deploy Intelligent Transportation Systems. Strong public-private partnerships will be established, in which each sector has a well-defined role in the development and deployment of Intelligent Transportation Systems. This is consistent with VDOT's vision for system management and personal travel:

> *"Private independent service providers (ISPs) will provide on-demand, route and mode specific information tailored specifically to the needs of their customers. The ISPs will use raw data provided by VDOT as well as their own data sources, and have their own analysis capabilities. Information will be available where and when travelers need it to make informed travel decisions."*

> *"ISPs will also provide on-demand traveler services information including descriptions of destinations and services, route guidance, and accurate traffic and weather conditions…VDOT and other public sector agencies will share the data they collect with the private sector. The public sector will also be responsible for developing the initial communication networks and institutional arrangements to move the data from the roadside to all possible end users of the information. Finally, the public sector will help promote the use of these private traveler information services in order to maximize the effectiveness in reducing traffic congestion and improving air quality."* (VDOT Smart Travel Business Plan)

Fourth, there will be significant advancements in software, hardware, and modeling. Advancements in traffic control algorithms and software will provide the capability to optimize signalization, offering more reliable travel guidance. Algorithms, software, and computer hardware will be advanced enough to allow for real-time route guidance. Improvements in surveillance, incident detection, communications, data processing, and other functions will result in the collection of more reliable data.

> *"Advanced communication and processing capabilities will provide greater access to ITS data by many different divisions and individuals within the Department to do their jobs more efficiently and less expensively than ever before..."* (VDOT Smart Travel Business Plan)

Further, VDOT is committed to supporting research in the areas of Intelligent Transportation Systems and traffic management and control:

> *"VDOT will offer the most comprehensive ITS research and development capability in the world through its universities, state and local governments, and private-sector partnerships."* (VDOT Smart Travel Business Plan)

Fifth, privacy issues related to surveillance, autonomy, and the collection of personally identifiable information will be addressed. Many individuals will accept having their vehicles act as probes. Measures will be taken to address privacy concerns. The use of advanced technologies to perform certain traffic management and control functions could raise some privacy issues. According to a series of court opinions, the right to privacy includes three interests: autonomy, intrusion, and informational privacy. Relating to intrusion, people are generally interested in being free from surveillance, specifically in circumstances where there is a reasonable expectation of privacy. Maintaining anonymity is a key aspect of this interest. Motorists may feel that some monitoring of their position in the network is a violation of their privacy. One could argue that despite the lack of anonymity, surveillance is in the interest of the public, particularly for safety reasons.

There may also be an issue of information privacy, which concerns ISPs or public agencies who control the collection, quality, use and dissemination of traffic information. Several measures can be taken to mitigate any concerns about privacy that may arise in the deployment of Intelligent Transportation Systems. This includes, for example, using encription programs to make personally identifiable information anonymous, seeking consent from motorists prior to collecting sensitive data on their travel, forming agreements that promote guidelines in the transfer of information between agencies.

Table 7. Traffic Control and Management

	BASE CASE		2010—HEAVY ITS INVESTMENT		
ITS ELEMENT	**DESCRIPTION**	**LEVEL OF DEPLOYMENT**	**DESCRIPTION**	**LEVEL OF DEPLOYMENT**	**DETAIL IN THE MODEL**
A. Traffic Management and Surveillance	Surveillance of traffic flow via Closed Circuit Television (CCTV) and Airborne video (helicopters).	VDOT(Smart Traffic Center) cameras at I-495 and Rt. 50, I-66 and Rt. 28, I-66 and River Oaks, I-66 and Exit 72, I-66 and Exit 68.	Continued surveillance of traffic conditions via CCTV and AirBorne Video. CCTV cameras added to study area.	CCTV cameras will be located on I-66, the Capital, Route 50 and Route 29.	HIGH
	Surveillance of travel times, traffic conditions, and incidents via *SmarTraveler* probe vehicles.	Currently, there are a few probe vehicles collecting information for Route 50, I-66, and the Capital Beltway. Information is self-reported.	Transponders, cellular technology, or some other technology will allow for automatic and more accurate reporting of traffic conditions and travel times.	The percentage of probe vehicles in the study area will increase to 30%. Surveillance will extend to Route 29. Travel times will be updated more frequently.	HIGH
	Loop detectors monitor traffic flow, vehicular speeds, and spacing between vehicles.	½ mile spacing on I-66 from the Capital Beltway to the Roosevelt Bridge	Nonintrusive detectors will continue to collect traffic information.	More loop detectors added as necessary.	HIGH
	MIST provides real-time graphics display of vehicle operations at intersections.	Selected intersections in the study area.	Vehicle operations at intersections will continue to be monitored.	Surveillance will include all signalized intersections in the study area.	LOW-MEDIUM
	Ramp meters regulate traffic flow entering I-66 during peak periods.	There ramps are located outside the study area.	Existing ramp meters will remain in place.	No additional ramp meters implemented.	LOW

	BASE CASE		2010—HEAVY ITS INVESTMENT		
ITS ELEMENT	**DESCRIPTION**	**LEVEL OF DEPLOYMENT**	**DESCRIPTION**	**LEVEL OF DEPLOYMENT**	**DETAIL IN THE MODEL**
B. Traffic Signal System	The Smart Traffic Signal System allows for signal adjustments in response to traffic conditions and for a central monitoring location to alter timing plans.	Selected intersections in the study area.	Adaptive Signal Control and optimization of coordinated signal systems.	The system will include all signalized intersections in the study area.	LOW
C. Transportation Management and Information Centers	The Smart Traffic Center monitors and operates ITS devices on several highway sections in Northern Virginia. The center provides the following functions: traffic monitoring and management, equipment maintenance, device control, incident management, and traffic information dissemination. The City of Fairfax also manages and controls traffic in the study area.	The Smart Traffic Center manages the10 mile stretch of I-66 between the Capital Beltway and the Roosevelt Bridge and the HOV facilities of I-66. The City of Fairfax manages traffic within its own corporate boundaries.	There will be one center (or set of integrated centers) to manage and control traffic in the study area. This center will be more advanced in terms of its ability to collect, process, and disseminate information and to manage traffic. These advancements are described in other sections of this table.	Coordinated and more comprehensive management of traffic in the study area.	HIGH

Table 8: Traveler Information Services

	BASE CASE		2010—HEAVY ITS INVESTMENT		
ITS ELEMENT	**DESCRIPTION**	**LEVEL OF DEPLOYMENT**	**DESCRIPTION**	**LEVEL OF DEPLOYMENT**	**DETAIL IN THE MODEL**
A. Pre-Trip Traveler Information	Local Television Channels provide periodic updates of traffic and weather conditions using CCTV video images and maps. Maps highlight where incidents are located.	Coverage limited mainly to A.M. and P.M. peak hour and to major highway segments (I-66). Market penetration: 100% of all motorists have access to this information; only 50% watch television or listen to the radio to get traffic information.	Local Television Channels will continue to provide periodic traffic updates as part of their morning and evening programming. In addition, television/Internet and ISPs will provide on-demand, real-time information. Coverage will extend to all arterials and highways in the study area as more CCTV video images of traffic will become available.	Coverage will be extended to all highways and arterials in the study area. Market penetration: 100% of all motorists will have access to this information; only 50% will seek information however the information will be more accurate and timely.	HIGH
	SmarTraveler T.V. provides exclusive coverage of weather and traffic conditions using CCTV cameras and maps. Maps highlight trouble spots in the network.	Coverage limited to A.M. peak hour (6:30 to 9:30). Access limited to portions of Fairfax County and Alexandria. Market penetration: relatively low: about 2% of all motorists. Customer base limited to geographic areas above.			HIGH

	BASE CASE		2010—HEAVY ITS INVESTMENT		
ITS ELEMENT	**DESCRIPTION**	**LEVEL OF DEPLOYMENT**	**DESCRIPTION**	**LEVEL OF DEPLOYMENT**	**DETAIL IN THE MODEL**
Pre-Trip Traveler Information (cont.)	The *SmarTraveler* web page ([www.*SmarTraveler*.com](http://www.SmarTraveler.com)) provides on-demand information on traffic conditions and estimated travel times for specific highway segments. Information is updated every 5 minutes.	Coverage limited to I-66 between Roosevelt Bridge and the Capital Beltway. Recent expansion 17.2 miles west of the Beltway. Market Penetration: relatively low: about 1% of all motorists, xx hits a day.	(see above)		
	The VDOT web	Market Penetration: unknown			
	VDOT phone service	Market Penetration: unknown	Motorists will continue to have access to traffic information over the phone as provided by 511 for example.	All motorists will have access to traffic information over the phone however only 50% will use the service.	HIGH
	SmarTraveler provides audiotext information on traffic conditions and estimated travel times for specific highway segments. Users can access information via a menu or by entering in a code for a particular route	Coverage is limited to major highway segments, including I-66, Route 50, and the Capital Beltway. Market Penetration: about 1000 regular customers			

	BASE CASE		2010—HEAVY ITS INVESTMENT		
ITS ELEMENT	**DESCRIPTION**	**LEVEL OF DEPLOYMENT**	**DESCRIPTION**	**LEVEL OF DEPLOYMENT**	**DETAIL IN THE MODEL**
B. En-Route Driver Information	(see above) phone service				
	In-vehicle Internet access to traffic information.	Market penetration: very low	Television/Internet and ISPs will provide on-demand, real-time information. Coverage will extend to all arterials and highways in the study area as more CCTV video images of traffic will become available.	Coverage will be extended to all highways and arterials in the study area. Market penetration: 30% of all motorists will have Internet access to this information either in their vehicle or through some mobile computer device.	HIGH
	Variable Message Signs (VMSs) provide motorists with information on network conditions such as incidents, HOV restrictions and gate opening/closings, etc.	Located at certain places on I-66 between Roosevelt Bridge and the Capital Beltway. Recent expansion 17.2 miles west of the Beltway. Minimal response to information provided via VMSs.	Change in the placement and information content of Variable Message Signs. Better coordination with other information services such as HAR, In-Vehicle Information Services.	Traffic information of the sort currently provided by VMSs will be made 95% accurate. Information will be refreshed every 5 minutes. VMSs will be placed in advance of all exits in both directions along the affected segment of I-66.	HIGH
	Highway Advisory Radio (HAR)	Use of HAR still relatively low.	Better coordination with VMSs.	Coverage will extend to all of the study area.	HIGH
	Traffic Reports on local radio stations	100% access/50% listen to the radio to get traffic reports.	Local radio stations will continue to provide periodic traffic and incident updates.	Motorists who used the radio to get traffic information in 2000 will switch to other sources (e.g., *SmarTraveler* or 511).	HIGH

	BASE CASE		2010—HEAVY ITS INVESTMENT		
ITS ELEMENT	**DESCRIPTION**	**LEVEL OF DEPLOYMENT**	**DESCRIPTION**	**LEVEL OF DEPLOYMENT**	**DETAIL IN THE MODEL**
C. Route Guidance	In-vehicle Internet access to traffic information.and route guidance.	Market penetration very low.	Customized route guidance and traffic information systems will be available to some motorists.	Market penetration: 30%.	HIGH

Table 9. Incident and Emergency Management

	BASE CASE		2010—HEAVY ITS INVESTMENT		
ITS ELEMENT	**DESCRIPTION**	**LEVEL OF DEPLOYMENT**	**DESCRIPTION**	**LEVEL OF DEPLOYMENT**	**DETAIL IN THE MODEL**
A. Incident Management	Surveillance via loop detectors, CCTV, probe vehicles, and aerial video.	(described in traffic management and surveillance section).	Advancements in traffic surveillance, management and control will reduce the number and duration of incidents.	The entire study area will be affected.	HIGH
	Latitudinal and Longitudinal radar sensing systems on vehicles for collision avoidance.	Low market penetration.	There will be advancements in these technologies allowing for a reduction in accidents.	There will be 50% market penetration in new vehicles and 2% retrofit of front and rear warning systems, and 15% new market and 1% retrofit for lateral warning systems (1997 Apogee/U.S. DOT market forecast)	LOW
B. Emergency Notification and Personal Security	Mayday services are an option on some new vehicles and through cellular phone service.	Market penetration low.	Mayday services will improve and increase incident response time.	Market penetration will increase significantly.	LOW

5. MODEL DEVELOPMENT

Several steps were involved in operationalizing the simulation model used in this study to evaluate Partners In Motion. Some of the tasks include coding the network, estimating inter-temporal origin-destination traffic demands, defining ITS-relevant parameters for each scenario, calibrating the model based on speed-flow relationships and capacities and validating the baseline model using existing travel times and traffic counts. The final task of conducting the simulation runs is discussed in Section 6.

5.1. Network Coding

The network used in this study extends from the Seven Corners area west of Baileys Crossroads and Roosevelt Blvd. to Fairfax Circle west of Vienna/GMU Fairfax Metro. This segment encompasses a major portion of both I-66 and U.S. Route 50, as well as a small section of the Capital Beltway, several major interchanges and signalized intersections, and some arterial roads and collector streets. The coded network used for the baseline scenarios has 567 links, 302 nodes, and 1980 origin-destination pairs. Figure 8 provides a schematic of this network.

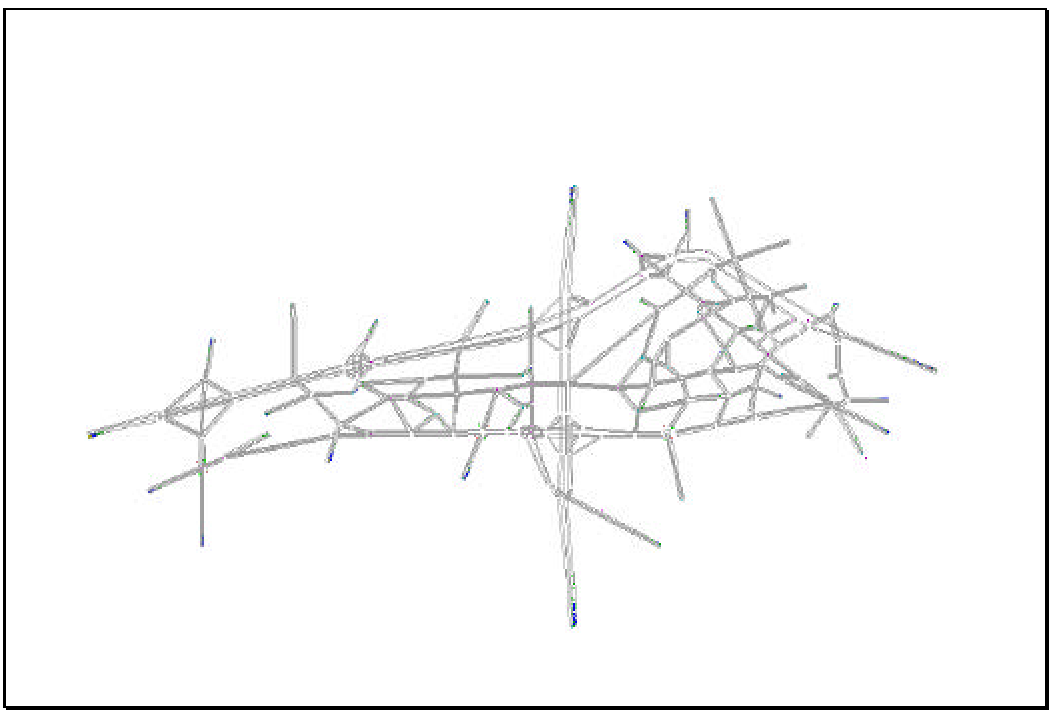


Figure 8: INTEGRATION Simulation Network

Several network configurations were considered before selecting a final version for this study. The constraints that INTEGRATION imposes on network size and complexity were critical in defining this network. In particular, the limitations relating to number of vehicles on the network and origin-destination traffic flow rates posed the greatest challenges. Traffic on I-66 and the Capital Beltway is currently relatively heavy, and these levels are projected to increase even further by the year 2010. The regional transportation model was used to estimate how many vehicles would be loaded on to each network under consideration. The program MINUTP was used to extract this information from the regional model. K-factors were used to convert these trips to A.M. peak period equivalent.

The selected network was subsequently coded for use in INTEGRATION. Coding involved three major tasks: extracting the subarea network from the regional network coded in MINUTP, converting variables in the MINUTP network file to the formats required for use in INTEGRATION, and adding any other variables required for simulation in INTEGRATION. These tasks were completed for both the 1999 and 2010 networks.

The program MINUTP was used to extract the corridor-level network and the respective link attributes from the 1999 and 2010 regional transportation networks. Some processing of this information was required in order to make it compatible with the formatting specifications of INTEGRATION. Each of the following had to be done:

- ✓ The bi-directional links in the regional transportation network each had to be converted to two uni-directional links;
- ✓ Some links in the regional transportation network had to be split as they exceeded the 6.0 km. maximum link distance imposed by INTEGRATION;
- ✓ Interchanges and the HOV facility on I-66 had to be detail coded –i.e., ramps, turning movements, etc. all had to be coded;
- ✓ The free-flow speeds and link distances had to be converted from miles to kilometers;
- ✓ Node attributes, such as turning movements, the presence of signals which control exit prohibitions, and access restrictions had to be defined;
- ✓ New nodes had to be added along with their x-y coordinates; and
- ✓ Other variables, including jam density, etc had to be specified for each link.

The INTEGRATION program also requires that trip origins and destinations, or zones, be specified. Several zones were transferred directly from the regional transportation network, including 21 located inside the subarea network, 11 just outside the study area boundary, and 12 macro-zones, or aggregations of external zones, located throughout the region. For example, all zones in the regional transportation model located in the District of Columbia were combined into one zone for the purpose of simulation in INTEGRATION.

5.2. Estimation of Origin-Destination Traffic Flows

Traffic demands in INTEGRATION are a time series of departure rates by time of day for each origin and destination. Unfortunately, origin-destination demands at this level of temporal detail were not available for the I-66 corridor. Consequently, the origin-destination matrix in the regional transportation planning model was used to estimate an intertemporal matrix for the study area based on assumptions regarding the percentage of daily trips occurring during the A.M. peak hour and the directional tendencies of this traffic. K-factors for each half-hour during the A.M. peak period were derived from traffic counts done on major highway facilities in the area, as shown in Table 11. This process was completed for both the 1999 and 2010 networks.

The regional origin-destination matrices used in this study were derived from the Round 6.1 cooperative forecasts of employment and population in the Washington, D.C. metropolitan area[14]. The cooperative forecasting process used by the Metropolitan Washington Council of Governments is characterized as a "top-down/bottom-up" procedure, by which local level forecasts are coordinated with those at the regional level. Each set of forecasts generated by this process is referred to as a "round."

The program MINUTP was used to extract from the regional transportation model all daily trips entering, exiting, or traveling within the subarea. K-factors were used to convert daily trips to appropriate A.M. peak period levels. Unfortunately, these factors were not available for all road segments in the network, and consequently, some judgement on the level and directional distribution on some major roads in the network had to be made. For example, it was assumed that for the A.M. peak period roads

[14] See www.mwcog.org

servicing primarily residential areas would have significantly more traffic going outbound in the morning, rather than inbound. Other adjustments to the origin-destination matrix were made in the calibration process.

Table 10: Location-Specific Temporal Distribution Factors

	I-66	Leesburg Pike	Dulles Access Road	Route 29	US 50 (Arlington Blvd.)	Gallows
6:30 A.M.	30%	8%	14%	5%	10%	6%
7:00 A.M.	14%	13%	16%	13%	15%	11%
7:30 A.M.	17%	20%	18%	20%	19%	19%
8:00 A.M.	17%	16%	19%	20%	19%	19%
8:30 A.M.	14%	15%	16%	18%	17%	19%
9:00 A.M.	14%	17%	12%	16%	17%	16%
9:30 A.M.	25%	15%	17%	13%	13%	17%
Total A.M. Peak Period	100%	100%	100%	100%	100%	100%

Source: *1998 Beltway Cordon Count*, National Capital Region Transportation Planning Board

INTEGRATION program also requires that for each origin-destination pair vehicle headways be specified. This is controlled through a parameter ranging from 0 to 1, where the fraction used represents the proportion of headway that is random. Unfortunately, data on the actual headway characteristics of trips leaving zones in the study area was not available so it was generally assumed that departure rates tended to be random. Some minor adjustments to this assumption were made in the calibration process.

5.3. Definition of ITS-Related Parameters

There are several ITS-related parameters that must be specified in the INTEGRATION program. These relate to driver classes, sources and use of traveler information, traffic surveillance, and intersection signalization.

5.3.1. Driver Classes and Traveler Information Sources

The INTEGRATION program requires that several parameters related to the deployment, quality, and use of Intelligent Transportation Systems be defined. Five driver classes were defined for the purpose of this study. Motorists in Driver Class 1 are assumed to base their travel decisions on historical experiences and they compute what they believe is a minimum path prior to leaving on their trip. Driver Class 2 represents all travelers eligible to utilize the HOV facilities on I-66. The source of travel information used by drivers in this class varies by scenario. Driver Class 3 includes motorists who listen to the radio and/or watch television to get travel information, but do not use *SmarTraveler*. Driver Class 4 are *SmarTraveler* users who have access to information that is moderately better than that provided on the television or radio. Further, they can access information on demand. Motorists in Driver Class 5 are assumed to have access to a high-grade traffic information service that provides real-time conditions in the network and route guidance.

The quality of information provided to each driver class is modulated by a parameter, which is essentially the coefficient of variation for travel times. The upper limit for this parameter is 25%, with a lower bound of 0% representing perfect information. Lastly, INTEGRATION allows for a certain percentage of motorists from each origin-destination pair to act as probes for the Traffic Management Center. Table 12 summarizes each scenario in terms of the average percentage of vehicles acting as probes on the network, the breakdown of motorists by driver class, and the quality of information provided to each of these class.

Table 12: Description of Drivers by Scenario

Scenario		Driver Class	%age Break-Down[15]	Qualityof Information[16] (error rate)	Update Frequency	% Probes
1	No ITS, No *SmarTraveler*	Driver Class1 Driver Class 2	90% 10%	25% (fair) 25% (fair)	Pre-Trip Pre-Trip	0%
2	ITS, No *SmarTraveler*	Driver Class 1 Driver Class 2 Driver Class 3	15% 10% 75%	25% (fair) 25% (fair) 25% (fair)	Pre-Trip En-Route (every 900 sec.) En-Route (every 900 sec.)	0%
3	ITS, *SmarTraveler*	Driver Class 1 Driver Class 2 Driver Class 3 Driver Class 4	15% 10% 73% 2%	25% (fair) 25% (fair) 25% (fair) 10% (good)	Pre-Trip En-Route (every 900 sec.) En-Route (every 900 sec.) En-Route (every 900 sec.)	0%[17]
4	Minimal Investment in ITS	Driver Class 1 Driver Class 2 Driver Class 3 Driver Class 4	15% 10% 73% 2%	25% (fair) 25% (fair) 25% (fair) 10% (good)	Pre-Trip En-Route (every 900 sec.) En-Route (every 900 sec.) En-Route (every 900 sec.)	30%
5	Heavy Investment in ITS	Driver Class 1 Driver Class 2 Driver Class 3 Driver Class 4 Driver Class 5	15% 10% 15% 20% 20%	25% (fair) 25% (fair) 25% (fair) 5% (good) 1% (excellent)	Pre-Trip En-Route (every 900 sec.) En-Route (every 900 sec.) En-Route (every 900 sec.)	30%

[15] These percentages represent averages over all origin-destination pairs. Some variation is assumed to exist. For example, a higher share of driver class 2 (HOV eligible travelers) is assumed for some of the west to east pairs where the HOV facilities on I-66 are a transportation option.
[16] This is amount of error introduced on into the link travel time data prior to calculation of minimum paths. 0% indicates no error while 50% is maximum error.
[17] Although there are currently vehicles acting as probes, the percentage of these vehicles is still relatively low.

Another feature of INTEGRATION is the ability to model Variable Message Signs and their impact on travelers' behavior. Stationary information sources, such as VMSs, are specified in the node file. For each driver class, it is necessary to indicate how their routing behavior will temporarily change (i.e., for 180 seconds) as a result of the information received from the device (i.e., for 180 seconds after coming in contact with the VMS). Travelers in Driver Class 1, for example, may momentarily take on the characteristics of Driver class 2. The proportion of total motorists (i.e., those from all Driver Classes) that will be responsive to the device must also be specified.

No variable message signs are specified in Scenario 1. Several devices are programmed in Scenarios 2 and 3, corresponding with what currently exists out in the field as detailed in Section 3, and in Section 4, which is a 2010 scenario with existing levels of Intelligent Transportation Systems. In each of the scenarios, all driver classes are assumed to take on the routing behavior of Driver Class 5 after passing a VMS. Only 10% of travelers are expected to change their travel behavior as a result of this event. Scenario 5 assumes improvements in the quality of information provided by VMSs and consequently, more responsiveness on the behalf of travelers. Twenty percent (20%), rather than 10% of all motorists are anticipated to react to the information provided by VMSs. The quality of information is modulated through the coefficient of variation factor assigned to Driver Class 5.

5.3.2. Traffic Surveillance

Real-time surveillance of any portion of the network as well as the status of this surveillance with respect to each Driver Class should be specified in the link file. Scenario 1 assumes no real-time surveillance to motorists while all others do assume that travelers have such information.

The optional link detector file was used to simulate the effects of loop detectors for all of the scenarios assuming some level of Intelligent Transportation Systems deployment. This includes Scenarios 2 through 5. The detector types are assumed to output data on a station-basis rather than an individual-lane basis. For each detector station, the effective detection length (km.) is assumed to be 0.005, which is a standard length. The polling frequency varies by scenario, with a frequency of 10 seconds for Scenarios 2 and 3, and a more frequent polling 1 seconds in Scenario 5. Again, Scenario 5 assumes significant improvements in surveillance technologies and capabilities.

5.3.3. Intersection Signalization

The INTEGRATION program has fairly sophisticated capabilities with regard to modeling intersection signalization. Modeling all 22 signalized intersections in the study area at this level of detail was beyond the scope of this project. Hence, only major intersections, such as those on U.S. 50 were programmed as being signalized. Actual signal timing plans for these intersections were used to specify realistic cycle lengths, effective green times, effective lost times, number of phases and other parameters for each of the intersections modeled.

5.3.4. Incident Management

One limitation of the program, INTEGRATION, is that it cannot explicitly model incident management systems. Rather, the effects of such systems have to be captured captured indirectly through the duration and number of incidents specified. Scenarios 1a through 5a are designed to assess the impacts of a major incident on the use and effectives of traveler information services. For each scenario, a major incident on I-66 with one-and-a-half lane blockage and a clean-up time of 60 minutes is programmed and simulated. The location of the incident is on the east-bound portion of I-66 just prior to the Capital Beltway.

5.4. Model Calibration and Validation

The final step in building the model is to calibrate the speed-flow-density relationships for each link in the network. In general, speed, flow and density are related in the following manner:

$$F = S \times D$$

where, F is the rate of flow in (vehicles per hour or vehicles per hour per lane), S is the space mean speed (miles per hour or kilometers per hour), and D is the density (vehicles per mile or vehicles per mile per lane). This study assumes that the speed-flow relationship on each link follows Greenshield's Linear Model. The reason for using this model over others is that it is simple, straightforward, and fairly well-established.

According to the model, there is a linear relationship between speed, S, and the density, D, where the extreme values include free-flow speed, S_f, and jam density, D_j. This relationship tends to exist when speed at capacity is half that of free flow speed, and jam density is 25% of link capacity divided by free flow speed. These guidelines were used in calibrating the speed-flow relationships on each link. Further, the link free flow speeds and the capacities contained in the regional transportation network link file were initially used to establish reasonable set of attributes for each link.

6. EVALUATION OF *SMARTRAVELER*

This section evaluates Partners In Motion in terms of the goal of reducing congestion and several objectives related to this goal. The incremental impact of *SmarTraveler* on congestion-related outcomes is assessed by comparing conditions under Scenario 3 (base case) with those simulated in Scenario 2 (base case without *SmarTraveler*). The impact of Intelligent Transportation Systems as a whole on congestion and delay is also assessed, specifically by comparing Scenario 2 (base case with Intelligent Transportation Systems but no *SmarTraveler*) with Scenario 1 (base case with no Intelligent Transportation Systems as a whole). The potential for Intelligent Transportation Systems, including *SmarTraveler*, to reduce congestion in the future (i.e., year 2010) is also examined by comparing conditions under Scenario 4 with those associated with Scenario 5. Scenario 5 assumes heavy investment in Intelligent Transportation Systems, coupled with significant advancements in the technologies used with these systems and reductions in some of the institutional barriers to ITS deployment. Scenario 4, on the other hand, assumes very minimal investment in ITS.

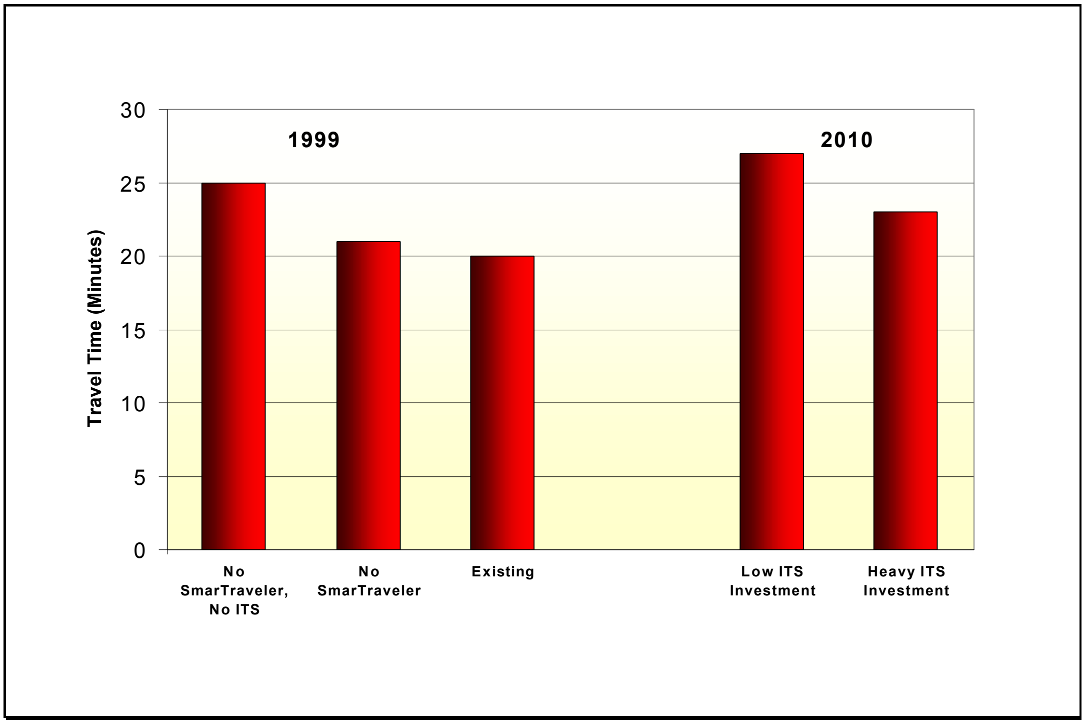
6.1. *Objective:* To reduce system-wide travel time during the peak periods

From a system-perspective, *SmarTraveler* appears to be having a positive impact on A.M. peak period travel time. With *SmarTraveler*, the average A.M. peak period travel time for all trips contained in the study area is 5% less than what it would have been without the service[18] (See Figure 9). Still the impact is minimal. This is not surprising though for a couple of reasons. First, the market share for *SmarTraveler* is still relatively low. Roughly only 2% of the driving age population in the Washington, D.C. metropolitan area currently use the service. Second, *SmarTraveler* covers only a portion of the I-66 corridor, namely I-66, US 50 and the Capital Beltway. Expansion of the service to other major facilities like VA 123 and U.S. Route 29 might enhance the decisions of travelers whose route alternatives include these highways.

[18] The average travel time is based on only the portion of each trip that is contained in the study area. For example, the travel time for a trip between Herndon and Fairfax City would not include the time it takes to travel from Herndon to some entry point into the study area network.

The collective impact of Intelligent Transportation Systems on system-wide congestion appears to be relatively significant. The average A.M. peak period travel time in the study area would be nearly 25% greater than what it is today if Intelligent Transportation Systems systems were not in place. These systems include the combination of Variable Message Signs, a certain degree of intersection signalization, traveler information services, loop detectors, and surveillance cameras.

Figure 9: System-Wide Average A.M. Peak Period Travel Time



Intelligent Transportation Systems could also be an effective tool for ameliorating system-wide congestion in the future. Without further deployment of ITS in the study area, average A.M. peak period travel time would be 25% greater than what could exist with heavy investment in ITS (See Figure 9). In other words, ITS could significantly enhance the effectiveness of the highway improvements planned for the I-66 corridor over the next decade. In particular, an increase in the use of traveler information services, like *SmarTraveler*, and improvements in the quality, timeliness, and relevance of information provided by these services, could contribute significantly to reductions in travel time. Recall Scenario 5 has a large ATIS component to it, assuming that 50% of the driving age population relies on a traveler information service like *SmarTraveler* or 511 and 30% will have access to high-grade, real-time traffic information along with route guidance assistance.

6.2. *Objective:* To reduce travel times during the peak periods for *SmarTraveler* users

While *SmarTraveler* appears to be having a positive, albeit moderate impact on average travel time experienced by all motorists in the study area, it does not appear to benefit *SmarTraveler* users specifically. In fact, the average travel time for driver class 4, or *SmarTraveler* users, is 11 % greater than the average for all driver classes (See Figure 10). Those who listen to the radio or view the television to get traffic information (Driver Class 3) currently have the lowest average travel time. Intelligent Transportation Systems appear to benefit all driver classes. With ITS, either including or not including *SmarTraveler*, all driver classes with the exception of Driver Class 4, have average travel times less than what they would have been without ITS (Scenario 1). Further, in the absence of ITS there is more variation in travel times suggesting that such systems could reduce uncertainty in traffic conditions.

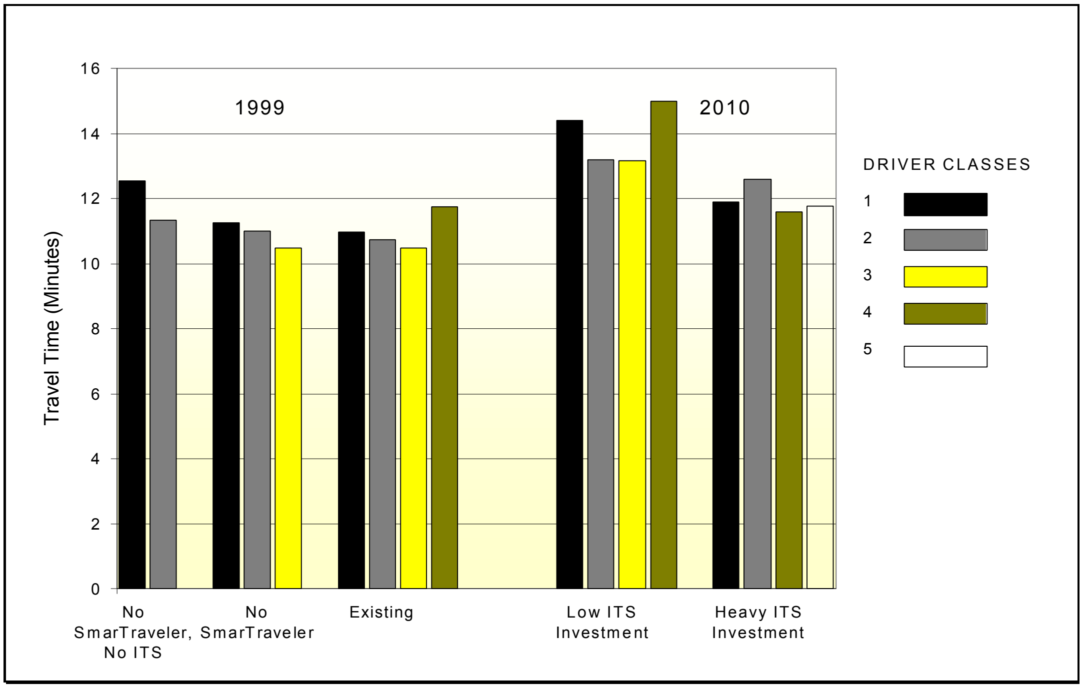


Figure 10: Average A.M. Peak Period Travel Time by Driver Class

Without further investment in Intelligent Transportation Systems, all driver classes appear to be worse off than they are today. Heavy investment in ITS could significantly improve the travel times of all driver classes, including *SmarTraveler* users. Of course, this assumes vast improvements in the quality, coverage, and timeliness of information provided by the service. Another potential benefit of ITS investment is that travel time uncertainty might be reduced. This is suggested by the fact that the standard deviations for average travel times for each driver class under Scenario 5 are less than those in Scenario 4.

One interesting finding is that motorists who have access to a high-end, real-time traveler information and route guidance service (Driver Class 5) do not benefit any more than those who rely on *SmarTraveler*. Notice the minimal difference in average travel times for Driver Class 4 and Driver Class 5 in Scenario 5. This finding is consistent with other studies that show that there is some optimal penetration rate for traveler information services. Recall, Scenario 5 has a strong ATIS component to it, with 50% of all motorists using a service like *SmarTraveler* and 30% using a higher-end service. Perhaps, the combined share of 80% exceeds what would be optimal for congestion mitigation.

6.3. *Objective:* To reduce travel times during the peak periods for specific highway facilities

SmarTraveler also appears to be having some impact on the average A.M. peak period travel times experienced on I-66 and US 50 (See Figure 11). With *SmarTraveler*, average travel times on I-66 and US 50 are 11% and 4.5% lower than what they would be otherwise without the service (See Figure 11). Variability in travel time, which might equate to uncertainty for travelers, is also reduced on both facilities. Intelligent Transportation Systems as a whole are having an even more profound impact on travel times along I-66 and US 50. In fact, without any systems in place, travel times on the sections of I-66 and US 50 contained in the study area could be almost 31.5% and 70.3% greater.

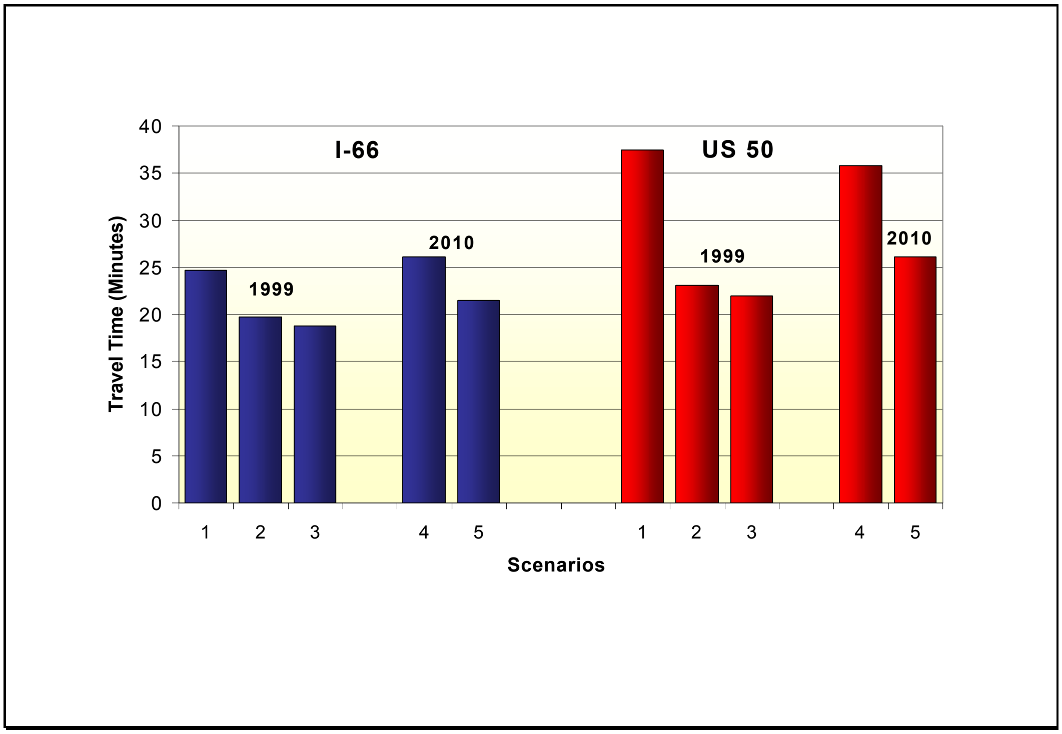


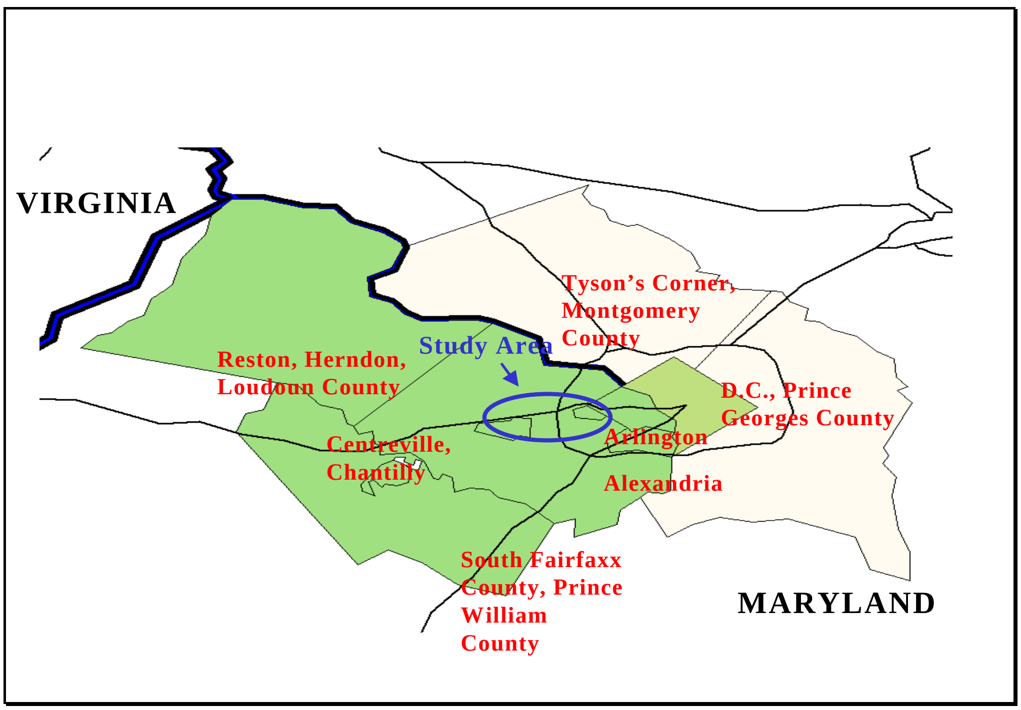
Figure 11: Average A.M. Peak Period Travel Time by Facility

The benefits of Intelligent Transportation Systems in terms of congestion mitigation appear to be greater on US 50 than I-66. This finding is supported by a couple of arguments. First, demand for carpooling is fairly inelastic, meaning that the share of motorists who select to carpool and use the High Occupancy Vehicle lanes on I-66 is relatively fixed. Barriers, ranging from logistical problems to attitudes and preferences about ridesharing preclude major shifts upward in the use of this mode of transportation. Therefore, the number of motorists who use I-66 east of the Capital Beltway, which is exclusively dedicated to HOV, remains relatively constant across the 1999 scenarios. There is very little difference between Scenarios 1 through 3 in terms of the average A.M. peak period traffic volumes on the section of I-66 just inside the Capital Beltway. Second, the level of congestion on I-66 just east of the Capital Beltway is minimal, even for the projected 2010 case. Perhaps, it is for congested facilities where the benefits of ITS can be the most pronounced.

6.4. *Objective:* To guide travelers to more efficient travel paths between origins and destinations

SmarTraveler appears to be helping to guide motorists to the most efficient paths between certain origins and destinations in the metropolitan area. Figure 12 highlights some of the major origins and destinations selected for the evaluation of *SmarTraveler* in terms of this objective. These locations represent major traffic generators, having a high concentration of households, employment activity, or both. Figures 13a through 13c show for each origin-destination pair the percentage deviations in travel times from the travel time associated with Scenario 3.

Figure 12: Major Origins and Destinations in the Metropolitan Area



Individuals with origins north of the study and a destination of the District of Columbia as well as those going from the Northwestern part of the metropolitan area to Alexandria appear to benefiting from the information provided by *SmarTraveler*. In particular, the average travel time for a person traveling between the first pair of zones is 5.6% less than what it would be today without *SmarTraveler*. These differences are slight though, and for some origin-destination pairs average travel times increased, as is the case for the Northwestern Fairfax to Washington, D.C.

Figure 13a: Average A.M. Peak Period Travel Time for Trips Having Origins North of the Study Area

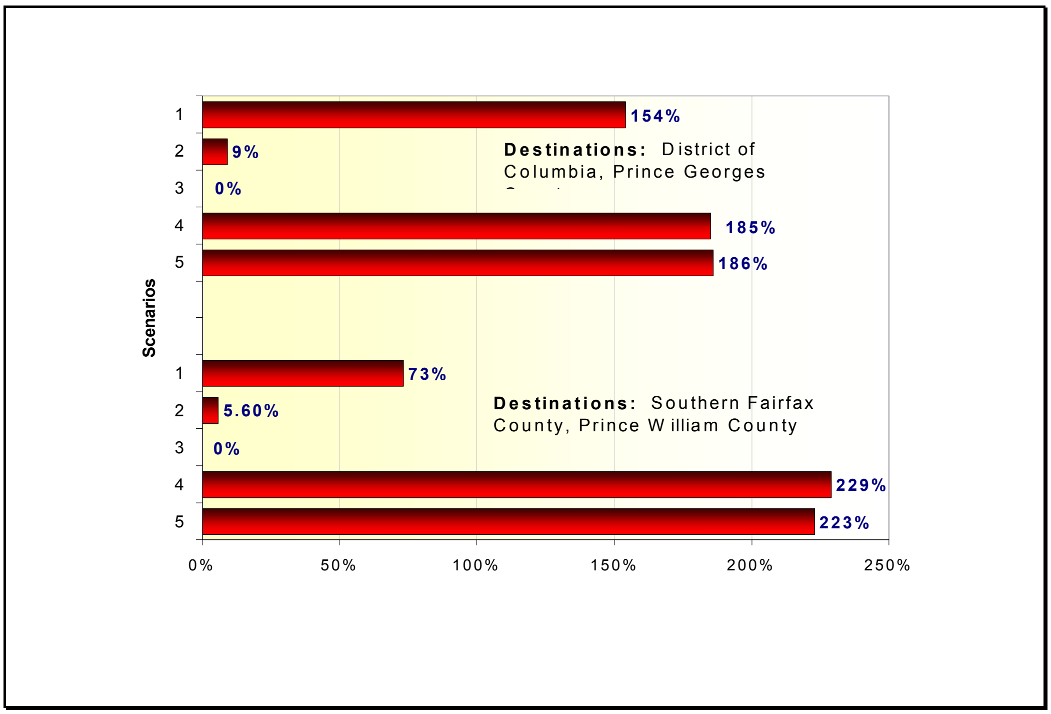


Figure 13b: Average A.M. Peak Period Travel Time for Trips Having Origins Northwest of the Study Area

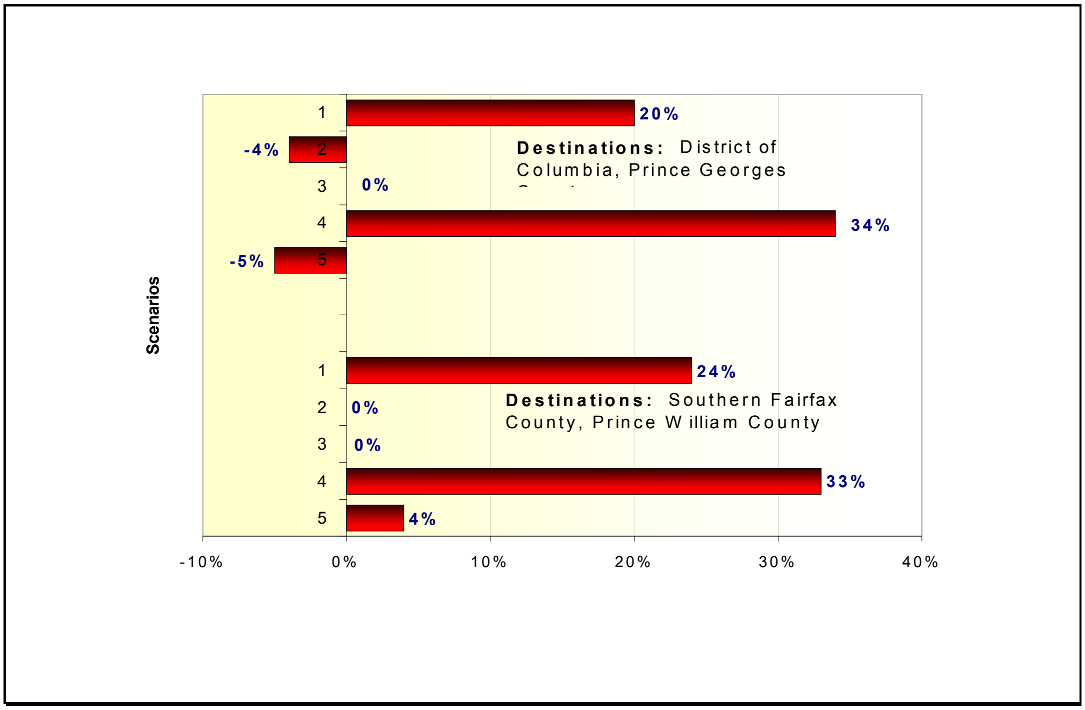
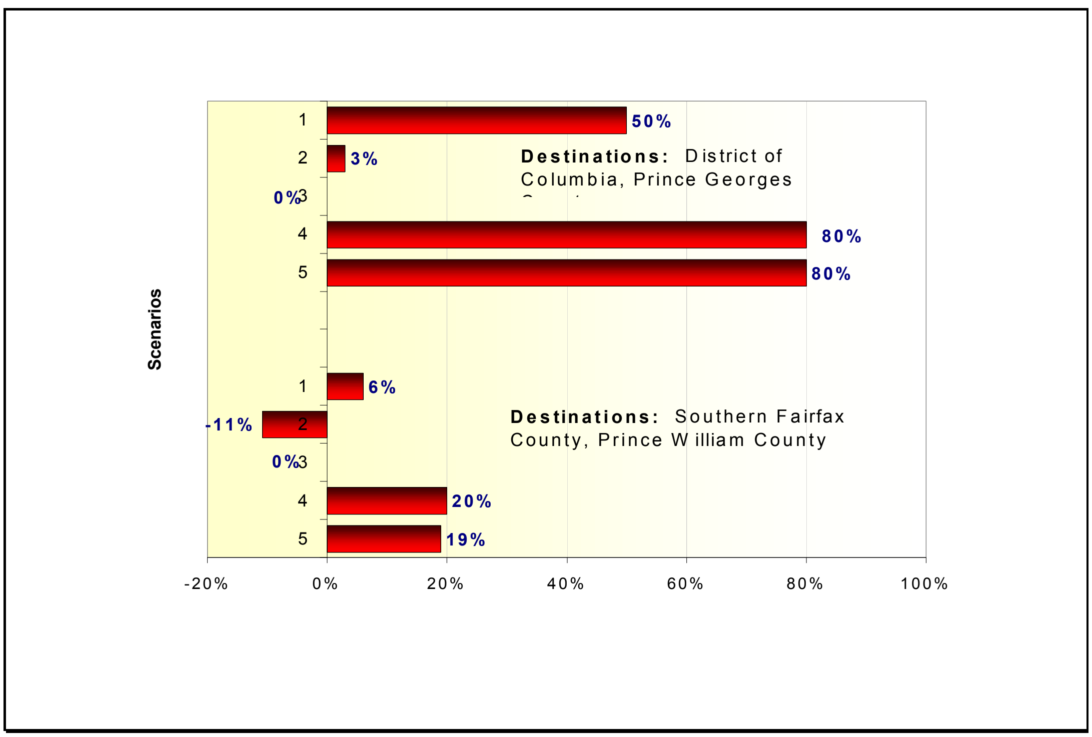


Figure 13c: Average A.M. Peak Period Travel Time for Trips Having Origins West of the Study Area

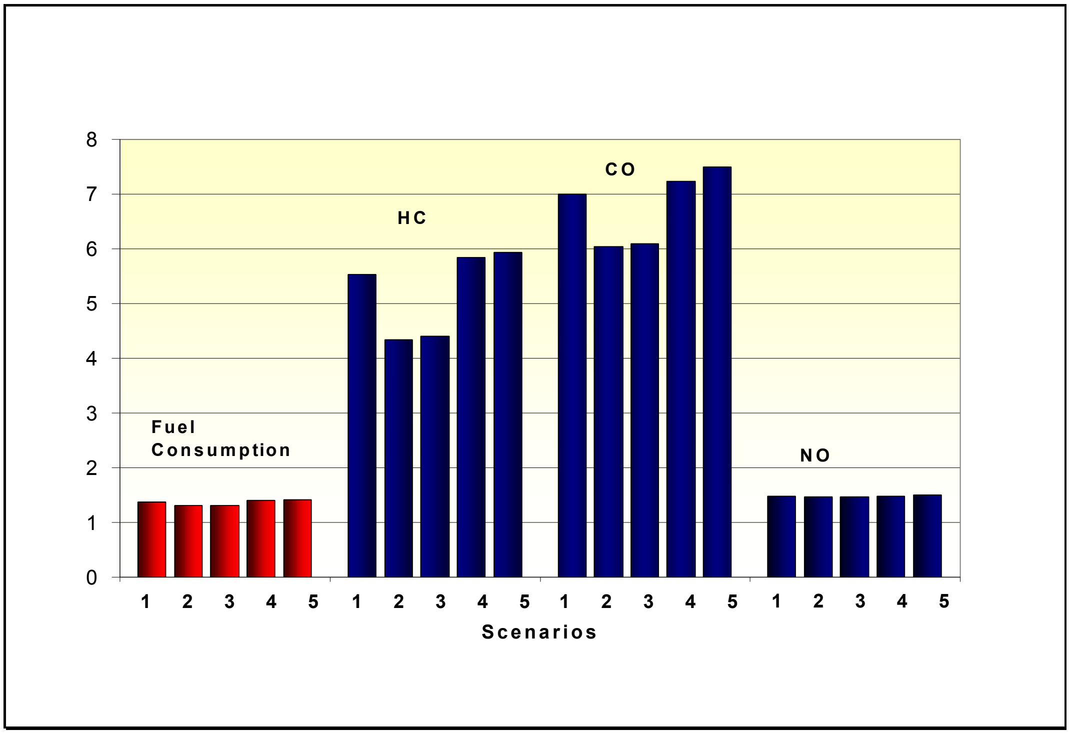


Intelligent Transportation Systems, as a whole, are also helping to guide travelers to more efficient paths between certain origins and destinations. The impacts appear to be greatest for travelers originating in the Northern portion of the metropolitan area (i.e., Montgomery County, McLean, Tyson's Corner). The impact that heavy investment in ITS could have on travel times in the year 2010 appears to be limited to a few origin-destination pairs, specifically the two which have Centreville as an origin. Motorists traveling from the Northern end to Southern portion of the metropolitan area, on the other hand, may not see any benefits from future deployment of ITS. Average travel times for these individuals could be significantly greater than what they are today, with or without more investment in ITS.

6.5. *Objective:* To reduce vehicular emissions and fuel consumption during the peak periods

The impact that *SmarTraveler* has had on average fuel consumption and vehicular emissions (CO, NO, and HC) appears to be minimal (See Figure 14). This finding is not surprising given that the service has had only slight effects on travel time and delay in the study area. It could be that any reductions in travel time, such as those experienced by motorists traveling between specific origin-destination pairs, might be offset by increases in vehicle miles traveled elsewhere in the network.

Figure 14: Average Fuel Consumption and Vehicular Emissions



As expected, Intelligent Transportation Systems as a whole, have helped to reduce average fuel consumption and air pollution. The most significant impacts have been on HC and CO. Similar benefits may accrue in the year 2010 with heavy investment in ITS.

7. CONCLUSIONS AND POLICY RECOMMENDATIONS

The study summarized in this report evaluates Partners In Motion, as it has developed over the last two years and how it may evolve over the next decade, with respect to the goal of reducing congestion. Several objectives related to this goal were examined. Outcomes for evaluating Partners In Motion were generated using a meso-scale simulation model of the I-66 Corridor in the Washington, D.C. metropolitan area. A.M. peak period traffic within this study area is simulated for three baseline scenarios and two future (2010) scenarios. The current and potential future impacts of Intelligent Transportation Systems, as a whole, are also explored in this analysis.

Several findings stem from this analysis:

- *SmarTraveler* does appear to have some impact on A.M. peak period congestion in the I-66 corridor, although the benefits are minimal and seem to apply to specific situations and travelers. For example, motorists whose trips originate north of the study area are experiencing average travel times that are less than what they would be without the service. It is important to note though that these motorists include some *SmarTraveler* users but mainly other travelers who are benefiting indirectly from the availability of the service.

- *SmarTraveler* users are not necessarily better off than other motorists in terms of making optimal departure time and route choices. In fact, the average travel time for *SmarTraveler* users is somewhat larger than those experienced by other driver classes. This finding though is specific to motorists who use the I-66 corridor in the A.M. peak period and may not generalize to other situations. Further, in a previous study, it was found that *SmarTraveler* users believe that the service is helping them to reduce their travel times, anxiety, and traffic problems.

- The combination of Variable Message Signs, a certain degree of intersection signalization, traveler information services, loop detectors, and surveillance cameras have had a profound impact on reducing congestion. The average A.M. peak period travel time for tripmaking within the I-66 corridor would be 25% greater today if such systems were not in place.

- Further deployment of Intelligent Transportation Systems, including *SmarTraveler*, could enhance the effectiveness of highway and transit improvements planned for the study area. Average travel times under the heavy ITS investment are significantly lower than those associated with the scenario assuming only minimal additional deployment of ITSs.

These findings provide some direction for future policies regarding ITS deployment in the Washington, D.C. metropolitan area. First, the benefits of *SmarTraveler* might be enhanced with a market share greater than the current 2%. Although there is probably some optimal penetration rate for the service that is a function of the quality, timeliness and relevance of traffic information provided by the service and the availability and use of other services. This is something that could benefit from further study. Second, further development and deployment of Intelligent Transportation Systems should be encouraged. Efforts should be made to foster institutional support, interagency cooperation and coordination, the provision of privacy safeguards, and research on algorithms and models for ITS.

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Virginia Department of Transportation www.vdot.state.va.us
Metropolitan Washington Council of Governments www.mwcog.org